

## SHARING IS CARING: SOCIAL SUPPORT PROVISION AND COMPANIONSHIP ACTIVITIES IN HEALTHCARE VIRTUAL SUPPORT COMMUNITIES<sup>1</sup>

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*Individuals increasingly rely on healthcare virtual support communities (HVSCs) for social support and companionship. While research provides interesting insights into the drivers of informational support in knowledge-sharing virtual communities, there is limited research on the antecedents of emotional support provision and companionship activities in HVSCs. The unique characteristics of HVSCs also justify the need to reexamine members' voluntary provisions of help in such communities. This paper develops a model that examines the relationships between the structural, relational, and cognitive dimensions of social capital and the provision of informational and emotional support, and engagement in companionship activities in HVSCs. The model is tested based on data generated through an automated method that classifies and analyzes user-generated text in three healthcare virtual support communities (breast, prostate, and colorectal cancer). The results show that all three dimensions of social capital impact the provision of emotional support; both structural and relational capital facilitate engagement in companionship activities; and only cognitive capital enables the provision of informational support. Research and practical implications on the need to facilitate informational and emotional support provision and companionship activities in healthcare virtual support communities are discussed.*

**Keywords:** Social capital theory, social support, healthcare virtual support communities, HVSCs, automated content analysis, text mining, emotional support, informational support, companionship activity

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## Introduction

Diagnosis and subsequent treatment of an important health problem, such as cancer, cause significant emotional trauma and often elevate feelings of vulnerability, uncertainty, loss of control, isolation, distress, depression, and anxiety (Anderson and Agarwal 2011; Braithwaite et al. 1999; Shaw et al. 2000). Individuals cope with these issues by seeking social support (i.e., verbal and nonverbal communications among individuals that reduce uncertainty about the situation and enhance the perception of personal control; Albrecht and Adelman 1987) and companionship activities (i.e., social interactions undertaken to satisfy participants' intrinsic needs for social integration and enjoyment; Rook 1987; Shaw et al. 2000). However, acquisition of face-to-face support may be difficult due to limitations in mobility, lack of access to a large enough pool of individuals facing similar issues, stigmatization due to the illness, feelings of burdening close social networks, and communication impairment (Braithwaite et al. 1999). Further, while close relatives and friends can provide physical assistance and aid, they oftentimes lack the knowledge and information to provide adequate support (Shaw et al. 2000). This creates a vicious cycle in which patients' support needs are heightened at the same time as access to support is impaired in face-to-face settings (Shaw et al. 2000).

Individuals increasingly turn to healthcare virtual support communities (HVSCs) as a way to complement and/or supplement the support they get face-to-face (Shaw et al. 2000; Wright and Bell 2003). By 2010, nearly one in four Internet users with chronic diseases participated in online health communities (Fox 2011). Individuals join HVSCs in an effort to expand their network of "supporters" beyond friends and family and access people who are experiencing similar conditions. They often seek informational social support (support that reduces uncertainty and/or facilitates problem-solving such as knowledge sharing; Pfeil 2009), emotional social support (support that restores emotional stability through the communication of love, sympathy, encouragement, etc.; Pfeil 2009), and companionship activities (such as camaraderie, joking, and sharing entertaining stories; Huang et al. 2014; Wellman and Gulia 1999).<sup>2</sup> Joining HVSCs also promotes a sense of universality and community (Braithwaite et al. 1999) and allows individuals to interact anonymously without social stigmatization (Shaw et al. 2000). Participants usually get access to more support (because of the size of the network) of better quality (because of easy access to greater expertise and the fact that individuals can rehearse and provide well-crafted

messages; Shaw et al. 2000). Further, it is also easier to obtain support when it is most needed (oftentimes in the middle of the night when anxiety tends to be higher). Through the sharing of personal feelings and emotions, coping stories, and life events, HVSC members learn from each other's experiences, and strong relationships, attachments, and norms of how to render help could form among them (Maloney-Krichmar and Preece 2005). Different from other knowledge-sharing virtual communities such as electronic networks of practice, sharing in HVSCs is a manifestation of caring for other members.

The support and companionship obtained in HVSCs have been found to positively influence psychological and physical outcomes of participants (e.g., Maloney-Krichmar and Preece 2005; Wright and Bell 2003). Participating in HVSCs facilitates positive coping (e.g., Barak et al. 2008; Rodgers and Chen 2005), increases self-efficacy in managing one's illness (e.g., Barak et al. 2008; Rains and Young 2009), reduces stress and depression (e.g., Rains and Young 2009; Rodgers and Chen 2005), and increases quality of life (e.g., Rains and Young 2009).

While we know a lot about the reasons why individuals join HVSCs and how they impact health outcomes, we know very little about the factors that drive members of HVSCs to provide support and companionship activities. This is a fundamental issue since the success of HVSCs depends on the willingness of community members to voluntarily contribute to the community. Some evidence suggests that social and helping norms influence contributions (e.g., Maloney-Krichmar and Preece 2002). Others have argued that contributions rest on the fact that HVSCs are characterized by high homophily, high attachment (e.g., Rodgers and Chen 2005; Wright 2015), and strong emotional bonds and identity resulting from a shared experience among community members (Wright and Bell 2003). Yet others argue that social interactions and relationship building are key to determine if, when, and how social support is provided (e.g., Braithwaite et al. 1999; Dunkel-Schetter and Skokan 1990; Shaw et al. 2000).

The above evidence suggests that taking a social and relational perspective can provide important insights into the factors that influence the provision of support and companionship in HVSCs. Drawing on social capital theory, the paper examines the relationships between social capital and the provision of informational and emotional support and engagement in companionship activities in HVSCs. It answers the following research question: *How do cognitive, structural, and relational dimensions of social capital impact the provision of informational and emotional support and engagement in companionship activities in HVSCs?*

<sup>2</sup>While some authors conceptualize companionship as a dimension or type of social support, the majority of the literature in psychology and social support (e.g., Bambina 2007; Rook 1987; Wang et al. 2014) differentiates them as we do in the present paper.

While IS research on social capital and online information-sharing communities can inform the present study (see Appendix A), care must be taken when drawing on this stream of research. Past conceptualizations of social capital and its effects must be adapted to the context of HVSCs because of their unique characteristics, such as the significance of emotional support and companionship activities (in addition to the sharing of knowledge and information), the urgency of obtaining social support and companionship, high homophily and attachment, and the volatility of participation patterns. Further, extant IS research has examined exclusively the antecedents of informational support provision and has not considered the provisions and antecedents of emotional support or participation in companionship activities, both of which are fundamental in HVSCs (Huang et al. 2014; Wang et al. 2014).<sup>3</sup> Studying support provision in HVSCs thus requires us to expand the dependent variable beyond informational support and also investigate the antecedents of the provision of emotional support and engagement in companionship activities. We also need to adapt the conceptualization and measurement of the components of social capital to the unique characteristics of HVSCs.

This study contributes to research in several ways. It complements prior IS research on HVSCs, which has not examined emotional support or companionship activities (e.g., Ma and Agarwal 2007; Zhao et al. 2013). Since providing emotional support and participating in companionship activities may play a critical role in sustaining virtual communities such as HVSCs (Ridings and Gefen 2004; Wang et al. 2014), the paper allows a more complete understanding about the factors influencing the longevity of HVSCs and virtual communities in general. The consideration of different support activities can also further IS studies on the ability of HVSCs to create social values to address public health issues. In addition, this paper adds to the IS literature on support provided in virtual communities that share similarities with HVSCs (i.e., urgency and volatility) such as communities used during disasters or crises (e.g., Oh et al. 2013; Pan et al. 2012). Moreover, this study uses automatic content analysis methods and thus responds to calls to adopt text mining methods to study online user-generated content (e.g., Luo et al. 2013). Finally, by informing the investigation of the socio-behavioral dynamics of patients' online participation, this research addresses recent

calls from the IS community to increase studies on the antecedents and outcomes of the design and use of patient-centered healthcare information systems (Anderson and Agarwal 2011; Fichman et al. 2011; Wilson and Strong 2014).

Our paper contributes to practice as well. By examining the relationship between social capital, social support, and companionship activities, this study suggests design guidelines that can support the development of dimensions of social capital to ultimately facilitate social support and companionship activities. Additionally, our findings show that in HVSCs, informational and emotional support, and companionship activities may be affected differently by the dimensions of social capital. This suggests that HVSC managers and designers can structure the community in a way that facilitates the achievement of desired specific support activities. These findings inform managers who are reaching customers via online campaigns by helping them understand the importance of knowing their customers' different online behaviors and their motivators. The text mining approach developed in this research can also be used by virtual community designers to develop automatic capabilities that could identify and push relevant postings and threads to specific members, suggest community experts to those who are in need of specific support, or match community members experiencing similar healthcare-related issues.

The paper is structured as follows. The next section provides the theoretical background on social support, social capital, and companionship. The subsequent section presents the model conceptualizing the social capital dimensions as the determinants of support and companionship, together with the hypotheses. The research method is detailed next, followed by a presentation of the results. The paper ends with a discussion of the findings, their implications, and conclusions.

## Theoretical Background

### *Unique Characteristics of Healthcare Virtual Support Communities*

While HVSCs share commonalities with other virtual communities (i.e., member engagement, sharing of information), they also have three major distinguishing characteristics. First, HVSCs have a broader functioning scope. In other virtual communities such as electronic networks of practice (e.g., Wasko and Faraj 2005) or brand communities (e.g., Wiertz and Ruyter 2007), the sharing of knowledge and information is the core activity for community participants. Informational support is only one element of HVSCs. Emotional support and companionship activities also play an important role in

<sup>3</sup>Although the term *social support* has generally been reserved for social science and healthcare disciplines, we consider the voluntary sharing of knowledge across social relationships studied in the IS literature as a type of social support transaction, that is, informational support. The definition of social support given by Albrecht and Adelman (1987, p. 19), "verbal and nonverbal communication between recipients and providers that reduces uncertainty about the situation...and functions to enhance a perception of personal control in one's experience," captures this informational, uncertainty-reduction aspect of social support.

HVSCs and tint key aspects of these communities (Huang et al. 2014; Wang et al. 2014). Individuals experiencing life-threatening situations are oftentimes in desperate need of emotional support and companionship, and they participate in HVSCs looking for those who are experiencing or have experienced similar life situations to exchange love, care, and encouragement—emotional support—and share life events, joke, or simply chat—companionship activities (Pfeil 2009; Shaw et al. 2000; Wright and Bell 2003).

Second, HVSC memberships are unique. Participants of HVSCs are often lay-people under emotional distress (Barak et al. 2008; Wright and Bell 2003). They have little control over their stressors and therefore can be quite anxious about their situations. Individuals in such situations tend to search for a context in which they can freely and safely disclose information about themselves and about risky topics with people who are experiencing similar situations (Barak et al. 2008; Wright and Bell 2003). HVSCs are therefore often characterized by high homophily and high attachment (Rodgers and Chen 2005; Wright 2015), which are based on strong emotional bonds and a strong identity among community members (Maloney-Krichmar and Preece 2002).

Third, the unique membership and broader scope of HVSCs shape the social dynamism and interaction characteristics of HVSCs. Participation in HVSCs is more volatile than in other knowledge-sharing virtual communities. Experiencing life-changing events is often accompanied by intense emotional reactions with high levels of uncertainty and anxiety (Anderson and Agarwal 2011), which can either inhibit or incite the provision of support in HVSCs (Wright 2000). Unlike other professional or consumer-oriented virtual communities, HVSC participants are more likely to experience a sense of urgency about contributing and receiving support (Radin 2006; Wright 2015). Thus rather than participating somewhat regularly (or intermittently with some dormant spells), the patterns of participation in HVSCs tend to exhibit initial bursts of activity that subsequently decline (Wright 2000; Yoo et al. 2013).

## Social Support, Companionship Activities, and HVSCs

### Social Support and Companionship

Social support researchers have examined two main types of health-promoting interactions—social support and companionship activities—that differ on several elements. Social support has been conceptualized as an uncertainty-reduction and stress-management mechanism (Albrecht and Adelman 1987; Thoits 1986). Companionship activities refer to the

shared leisure and activities that are undertaken primarily for the intrinsic goal of enjoyment (Rook 1987).

Further, social support and companionship activities influence various dimensions of well-being and outcomes in two different and complementary ways: the direct effect and the buffering effect (Rook 1987, 1995; Shaw et al. 2000; Wright 2000). Companionship activities affect well-being through the direct effect model, that is, they directly enhance well-being, regardless of specific life conditions and the presence or absence of stressors. Companionship activities can elevate current levels of well-being beyond baseline levels by protecting people from loneliness resulting from health problems (Rook 1987). Social support has beneficial effects on well-being by buffering (alleviating or eliminating) the deleterious effects of stressful events and protecting individuals from health damaging effects of such events (e.g., anxiety, uncertainty, self-doubt) (Rook 1995). By protecting or helping people to recover from emotional losses and expanding the resources available to them, social support serves to restore disrupted functioning and psychological equilibrium to a baseline level (Rook 1987, 1995).<sup>4</sup> Social support can also elevate self-esteem and self-efficacy, and reduce uncertainty (Cutrona et al. 1990).

The motivations for seeking companionship and social support also differ. Social support is mainly motivated by the need for help and assistance with personal problems and emotional distress. Companionship activities are sought not to solve a problem, but to experience interpersonal rewards and for hedonic purposes (Rook 1987, 1995). These interactions are sought for their own sake and for intrinsic satisfaction. Further, while individuals typically seek social support during a time of crisis, they participate in companionship activities regardless of the existence of negative events (Rook 1987).

### Types of Social Support Relevant to HVSCs

Research has proposed various typologies of social support. For example, House (1981) classified social support into emotional, instrumental, informational, and appraisal support. Cutrona et al. (1990) distinguished information, esteem, tangible, emotional, and network support. In general, acts of support fundamentally belong to three main functions: facilitating emotional recovery (i.e., support oriented to restore emotional stability through the communication of love, sympathy, encouragement, etc.), helping problem-solving and

<sup>4</sup>While some scholars have argued that social support might affect well-being directly (i.e., a direct effect) and occur in the absence of stressors, the empirical evidence indicates that this is very unlikely (Rook 1984).

uncertainty reduction (informational support), and providing instrumental and tangible assistance, most often through physical aid (Helgeson 2003).

Among the three main supportive functions, informational and emotional social support are the most frequent and important types of support in HVSCs (Pfeil 2009; Shaw et al. 2000; Wang et al. 2014). Social support research indicates that individuals join HVSCs to complement the support they obtain face-to-face, frequently consisting of tangible and physical assistance. Instrumental support, while amenable to HVSCs, is not frequently sought after in these communities (Pfeil 2009; Shaw et al. 2000). The rarity of this type of support is also due to the fact that instrumental assistance involves the provision of tangible help and services that often require physical presence and proximity, and HVSCs members are normally geographically dispersed and interact virtually (Pfeil 2009; Wright and Bell 2003). Extant healthcare research shows that instrumental support was not observed and was the least visible support type in HVSCs (e.g., Blank et al. 2010; Braithwaite et al. 1999; Finn 1999). In fact, there has long been concern about the ability of virtual communities to transact instrumental social support (e.g., Walther and Boyd 2002).

In summary, the health and social support literatures indicate that the two main types of social activities in HVSCs are social support (informational and emotional support) and companionship activities (Huang et al. 2014; Pfeil 2009; Shaw et al. 2000). These activities constitute complementary social interactions that are substantially different and are therefore likely to be influenced by different elements of social interactions and social contexts (i.e., social capital in HVSCs in our study).

### **Social Capital Theory**

Social capital (Burt 1992; Coleman 1988; Nahapiet and Ghoshal 1998) refers to the existence of social connections, and the relational assets, such as norms and identity, that are embedded therein. As an intangible capital, the emergence and maintenance of social capital allow connected partners to enjoy privileged benefits, such as increased accessibility to useful information (Burt 1992) and the mobilization of social actions (Coleman 1988), including social support interactions (Wellman and Wortley 1990). The idea that social interaction creates connections that permit access to, and exchange of, resources is the fundamental proposition of social capital theory (Nahapiet and Ghoshal 1998). According to Nahapiet and Ghoshal (1998), social capital is made of three dimensions (structural, relational, and cognitive), through which collective activities can be facilitated.

Structural capital concerns the impersonal configuration of an individual's social relationships representing who one reaches and when and how one reaches them (Burt 1992; Nahapiet and Ghoshal 1998), that is, the level of structural embeddedness of an individual (Granovetter 1992). Relational capital represents the quality and nature of social relationships (Bolino et al. 2002), or relational embeddedness (Nahapiet and Ghoshal 1998). Specifically, this dimension of social capital is about the type of relationships, such as friendships, formed and maintained by individuals (Granovetter 1992). It is also about the social assets, including norms and social identities that are created and leveraged (Nahapiet and Ghoshal 1998). Finally, the cognitive dimension of social capital refers to resources that promote shared understanding and interpretations among connected individuals which capacitate them to engage in communications (Nahapiet and Ghoshal 1998).

Social capital theory thus provides an appropriate theoretical lens for examining the existence, maintenance, and consequences of social relationships inherent to HVSCs. This study specifically adopts Nahapiet and Ghoshal's three-dimensional social capital framework since social support researchers argue that it is only when social relationships are conceptualized and measured using their different quantity and quality aspects, that deeper insights into the social support phenomenon and how it is afforded by social relationships can be revealed (House and Kahn 1985). In HVSCs, social interaction ties are created through the sharing of social support across members in the community (structural capital), and the self-disclosure of sensitive experiences and negative emotions require a supportive norm as well as trust that other members will not take advantage of shared information (relational capital). Finally, in order to make such sharing possible and understandable, both interactants need to share healthcare-related knowledge (cognitive capital). Recently Nahapiet and Ghoshal's social capital framework has been adopted to investigate individual membership continuation intention (Zhao et al. 2016) and knowledge contribution (Chang et al. 2016; Zhao et al. 2013) in healthcare-related virtual communities. Thus, we believe that this integrative framework provides a comprehensive view of different aspects of social relationships and allows for deep insights into the online social support and companionship phenomena.

According to Adler and Kwon (2002) and Nahapiet and Ghoshal (1998), the dimensions of social capital trigger the outcome benefits through three conditions: opportunity, motivation, and ability. Specifically, structural capital affects social activities primarily through its creation of access opportunities, relational capital motivates these social actors, and cognitive capital ensures their abilities to conduct social activities (Nahapiet and Ghoshal 1998). Further, these social

capital dimensions are also themselves associated with each other, activating the three conditions indirectly and leading to social outcomes (Nahapiet and Ghoshal 1998). Thus, we argue that the structural, relational, and cognitive dimensions of social capital influence individual social support provision and engagement in companionship activities in HVSCs through their creation of opportunities, motivations, and abilities, respectively, among members of HVSCs.

## Model and Hypotheses

Our model (Figure 1) takes into account findings in extant IS research about the social dynamics of virtual communities (see Appendix A), as well as the aforementioned unique features of HVSCs—broader scope of social interaction in the community, high homophily and attachment among members, and urgency and volatility of participation—in the conceptualization of the antecedents of informational and emotional support behaviors and companionship activities. To be faithful to the conceptualization of Nahapiet and Ghoshal (1998) in which each social capital dimension is itself a multidimensional construct that consists of components such as norms, social identity, and shared language, we draw on the hierarchical modeling approach (Wetzels et al. 2009) and model structural, relational, and cognitive capital as higher-order constructs that link to social support and companionship. This allows us to identify and conceptualize the key forming components of the social capital dimensions that are inherent in the context of HVSCs.

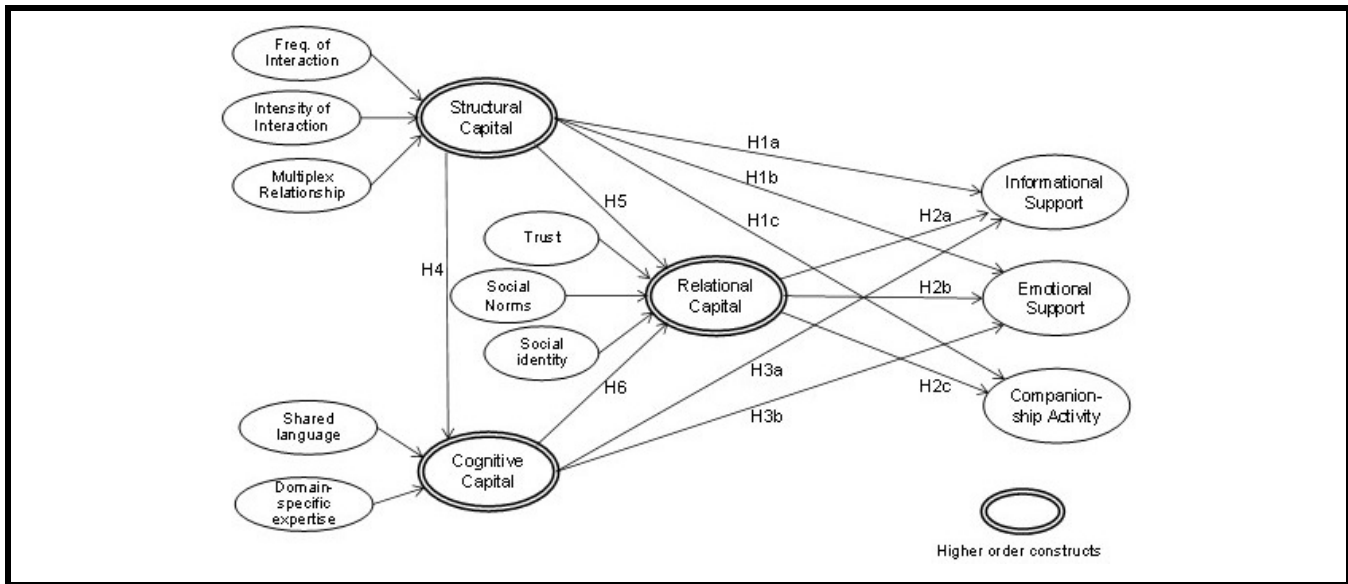
### **Structural Capital, Support Provision, and Companionship Activities**

The degree to which one is structurally embedded within social relationships determines one's opportunity to exchange useful resources (Burt 1992; Granovetter 1973), such as health-related information and informal healthcare (Kawachi and Berkman 2001). Structural capital reflects the amount of time individuals spend together and the extent to which they interact with each other (Chiu et al. 2006; Karahanna and Preston 2013). As pointed out earlier, individual participation in HVSCs may exhibit an initial burst of activity and then their need for support and participation may wane (Wright 2000; Yoo et al. 2013). However, community members who spend time and effort to develop structural capital tend to believe that the benefit from their staying in the community outweighs the costs of both community participation and community discontinuation (Bateman et al. 2011; Butler et al. 2002). Therefore, they are more likely to stay and provide support. In this study we follow Adler and Kwon (2002),

Ellison et al. (2007), Granovetter (1973), and Nahapiet and Ghoshal (1998) and conceptualize the extent of interaction—the structural capital—as a multidimensional construct formed by factors characterizing individual social interactions including the frequency, intensity, and multiplexity of community participation.

Community members participate in HVSCs to discuss numerous health-related issues, personal concerns, emotional states, and companionship activities. High *frequency* of interactions provides more opportunities for individuals to interact with different community members over different issues (Fiore et al. 2002). In the context of HVSCs, this frequent exposure to members discussing different topics in different discussion threads provides greater opportunities to sense the diverse healthcare needs of other members. High *intensity* of interactions leads to more in-depth conversations among interactants, resulting in the exchange of difficult-to-transfer, tacit knowledge for solving problems (Yli-Renko et al. 2001). *Multiplexity* of social interactions represents the formation of appropriable social organizations, where social relationships formed for one purpose are appropriated for other purposes (Coleman 1988; Nahapiet and Ghoshal 1998). A HVSC is not only an arena for people to exchange support, but also a place for community members to interact for companionship purposes such as chatting or sharing jokes (Huang et al. 2014). Through appropriable social organizations, information flows between members are broader and more diverse due to the existence of multiplex channels for interaction (Nahapiet and Ghoshal 1988).

We expect that in HVSCs, structural capital will increase opportunities to provide informational support. Because healthcare stressors are normally associated with uncertainty and anxiety, individuals experiencing stressful situations seek information from others with urgency in order to reduce uncertainty (Glanz and Schwartz 2008). This is done through increased help-seeking and/or self-disclosure of personal information (Barak et al. 2008; Vogel and Wester 2003), resulting in a burst of participation in HVSCs, reflected by increased message postings and/or thread initiations (Yoo et al. 2013). Consequently, HVSC members with frequent and broad participation in different discussion threads are exposed to community members' various needs. The increase in the intensity of dialog within discussion threads among community members affords more opportunities to be contacted for help, and/or to become aware of the urgent needs of others. Additionally, the engagement in multiplex interactions provides community members with multiple occasions and contexts to interact and exchange personal information, which increase the opportunities for them to sense each other's needs (Barnes and Duck 1994). Members with high levels of structural capital are therefore more likely to either encounter



**Figure 1. Research Model**

support requests from others, or become aware of community members' urgent information needs, and are therefore more likely to provide information to help other members. They are also able to acquire more information about others' illnesses, diagnoses, treatment regimens, and so forth, and thus know how to provide informational support to help others deal with current difficulties (Barnes and Duck 1994).

Moreover, an individual with high levels of structural capital will be more likely to have a rapid sense of other community members' urgent information needs (Burt 1992; Nahapiet and Ghoshal 1998), increasing his/her opportunity to provide informational support. This is particularly relevant in the context of HVSCs due to the urgent nature of supportive interactions. Individuals who do not engage in frequent, intense, or multiplex interactions in HVSCs are less likely to have opportunities to provide informational help since others with high levels of structural capital may have already contributed earlier. Individuals engaging in social interactions may also be more likely to be known, in terms of experience and/or expertise, to others. This gives him/her a greater chance to be solicited for, and thus to provide, informational support (Ryan et al. 2005; Wellman and Wortley 1990).

We also expect structural capital to be positively associated with the provision of emotional support. People tend to share their negative emotions when encountering stressful events (Rimé et al. 1991; Wills 1985), which is a strategy for soliciting emotional support (Cutrona et al. 1990). As indicated above, emotion and emotional support play a key role in HVSCs, which is a distinguishing feature of this type of

virtual community. People facing stressful events and having an urgent need of care and understanding from others with similar experiences would come to HVSCs. Therefore, HVSC members with frequent, intense, and multiplex participation in different discussion threads, that is, with high levels of structural capital, have more opportunities to be aware of other community members' emotional states and distress, making them more likely to provide emotional help. Structural capital also increases one's awareness about different community members' various stress-related experiences. Therefore, a member with a high level of structural capital has more opportunities to remind distressed members of the existence of other community members with similar experiences, showing them that they are not alone. Through frequent and intense social support exchange, one also has more opportunities to express appreciation for, and to validate and acknowledge others' contributions. Both of the above are forms of emotional support (Cutrona et al. 1990). Further, the increased access to information about connected parties, through frequent, intense, and, especially, multiplex interactions, allow community members to discover a variety of similarities, such as socio-demographic information, shared experiences, and hobbies (Brown 2001). This promotes empathy and concern for others' welfare, which fosters emotional helping (Håkansson and Montgomery 2003; Wright and Bell 2003).

Additionally, we hypothesize that in HVSCs, one's structural capital is positively associated with one's participation in companionship activities. Discussions created for companionship purposes are common in HVSCs (Huang et al. 2014),

given their broader scope of social behavior, relative to other virtual communities. Community members with high levels of structural capital are more connected to others and are more likely to identify a variety of similarities with other members. These members therefore have more opportunities to identify shared interests and hobbies and engage in companionship activities. Further, when community members form multiplex relationships, they participate in community activities not just for the main purpose of exchanging emotional or informational support (Walther and Boyd 2002), but also to seek opportunities for enjoyment and being together with other members. The more an individual engages in multiplex relationships with other community members, the more opportunity one has to be exposed to, or be invited to join, discussions for companionship purposes. Based on the above discussion, we hypothesize:

**Hypothesis 1a:** Structural capital is positively associated with the provision of informational support in HVSCs.

**Hypothesis 1b:** Structural capital is positively associated with the provision of emotional support in HVSCs.

**Hypothesis 1c:** Structural capital is positively associated with participation in companionship activities in HVSCs.

### **Relational Capital, Support Provision, and Companionship Activities**

Relational capital represents strong relational bonds—affectionate and close relationships—among individuals through which they trust, share norms, and identify with one another (Bolino et al. 2002). *Social identity* is the psychological state in which one sees oneself as a member of, and belonging to, a social group (Hogg and Abrams 1988). It is also about an individual's affective commitment to a group, as well as one's positive evaluation of the group (Ellemers et al. 1999; Hogg and Abrams 1988). By identifying with a group, one's self-concept is "largely composed of self-descriptions in terms of the defining characteristics of social groups to which one belongs" (Hogg and Abrams 1988, p. 7). Research has shown that social identity fosters prosocial, citizenship behaviors toward the group he or she belongs to and its members (Bergami and Bagozzi 2000), as identification with a group results in in-group favoritism (Ellemers et al. 1999). Social identification processes can be further facilitated in online communications. According to the social identification/deindividuation (SIDE) model (Spears and Lea 1994), the absence of nonverbal cues can obscure and undermine

perceived interpersonal differences. In such an environment, one tends to "deindividuate" others and the self, define each other in terms of the salient group characteristics, and engage in behaviors implied by the group identity (Postmes et al. 2005; Spears and Lea 1994). This phenomenon is especially important in HVSCs because of the high homophily (community members' clear and shared purposes and foci, and the fact that they connect like-minded individuals who are driven by community participants' eagerness to find others facing similar issues), as well as high emotional attachment toward the community and its members, that characterize this type of virtual community (Wright 2000; Wright and Bell 2003), and drive social support provision in HVSCs (Tanis 2007). Social identity is especially relevant for individuals living with illnesses because of the high uncertainty, and therefore the urgent need to know more about their health situation (Brashers et al. 2004). Through the social identification process of uncertainty reduction, HVSC members' perceptions of the stressors are likely to be assimilated into that of the group characterization ascribed to by members of HVSCs (Hogg and Terry 2000).

*Social norms* are the informal rules and standards of a group that emerge out of social interactions and influence group members' social behavior without the force of laws (Coleman 1988). Social norms represent a degree of consensus in the social system (Nahapiet and Ghoshal 1998), in which socially desirable behavior is valued and rewarded, and unacceptable behavior is sanctioned (Coleman 1988). The formation of such a social asset motivates one to act, by engaging in helping activities or collaboration with others, in order to promote collective interests (Coleman 1988; Nahapiet and Ghoshal 1998). Previous IS research has highlighted the key role social norms play to drive voluntary contributions in virtual communities (e.g., Chiu et al. 2006). Being a group member, social norms prescribe the expected role functions, and in the context of HVSCs, the key membership role function is being supportive of others, thereby fulfilling the expectations held by community members (Maloney-Krichmar and Preece 2002). The norm of being supportive represents the existence of a prevailing and socially shared value of caring about others' welfare by providing support (Maloney-Krichmar and Preece 2002; Peterson 2009). Social norms toward helping others is an especially prominent component in HVSCs, compared to other virtual community types, since helping norms are more likely to be activated in a context where emotion exchange and arousal abound, and the exposure to the urgent needs to others is frequent (Schwartz 1977), features that highlight HVSCs.

Among the relational assets that are embedded within relationships, *trust* has been a focus among researchers and practitioners (e.g., Coleman 1988). Following Pavlou and



Gefen (2004), we conceptualize trust as one's trust in the collectivity of online users. Trust is about one's belief that others will meet their responsibilities to oneself (Ommen et al. 2008) and that the results of others' intended actions will be appropriate (Misztal 1996). Such trusting beliefs are important in predicting social exchange and cooperative interactions (Chiu et al. 2006; Sarker et al. 2011). Trust is also positively associated with one's sensitivity to the needs of others and one's concern for others' welfare, and therefore individuals in trusting relationships are more supportive (McAllister 1995). Trust is especially relevant in the context of HVSCs, where trust sustains community members' continued HVSC participation (Fan et al. 2014). This is because social support exchanges in HVSCs rely heavily on community members' expressions of emotions as well as the disclosure of sensitive experiences about themselves (Wright and Bell 2003). Self-disclosure requires message posters to trust that their private, health-related information will not be abused by message readers, and that the readers will provide needed help instead (Jiang et al. 2011). The fact that many people who participate in HVSCs are laypeople, lacking pertinent knowledge and seeking trustworthy information (Barak et al. 2008; Fan et al. 2014), also reinforces trust as a relevant component of relational capital in this study.

We hypothesize that, in the context of HVSCs, individuals with high levels of relational capital toward the community and its members will provide high levels of informational support. Relational capital is likely to motivate members to share information because, through increased trust, social identification, and conformation to the helping norms, it reduces one's concern of being vulnerable to the recipient when sharing useful information (Butler 1999), creates a cooperative climate, and increases a feeling of responsibility for collective benefits (Nahapiet and Ghoshal 1998). This causal relationship is especially salient in the context of HVSCs within which members with high levels of relational capital can be highly motivated to provide informational help to other members. Specifically, HVSCs feature strong emotion bonds among members with high levels of relational capital, which result from high homophily and attachment, due to their common fate; salient helping norms, due to shared emotional distress and a frequent exposure to the urgent information needs of others; and trusting relationships, due to increased self-disclosure. This strong identification among people sharing stressors, the normative pressure to provide information and opinions, and the tendency to self-disclose sensitive information in HVSCs are all powerful motivators that drive members who are high in relational capital to proactively engage in support exchange and provide needed information when there is an opportunity (Drury et al. 2009; Fan et al. 2014; Maloney-Krichmar and Preece 2002; Zhao et al. 2013).

Relational capital will also lead to provisions of emotional support in HVSCs. In addition to the aforementioned helping norms and trusting relationships, the frequent exchange of emotions as well as high homophily and attachment characterizing HVSCs further drive these community members to provide emotional support. Specifically, for support seekers, the sharing of emotions with close others when experiencing distressing events is an integral part of one's emotional process (Rimé et al. 1991). For support providers, being exposed to others' expressions of emotions and feelings, especially unpleasant ones, can be contagious (Hatfield et al. 1992), and this contagion process is fortified when one identifies with a group such as members of HVSCs (Hogg and Terry 2000), where the frequent exposure to emotions of other members also increases one's tendency to be emotionally aroused. This sharing and spreading of emotions motivates the provision of emotional support, not only for the purpose of restoring support seekers' disrupted mental functions. For HVSC members who identify with, and who are therefore easily affected emotionally by distressed others, the provision of emotional support is also an active coping strategy for support providers to improve their affected moods (Van Kleef et al. 2010). Additionally, by identifying with similar others, individuals tend to empathize more with one another (Hogg and Terry 2000) and therefore are more motivated to share emotional support to respond to other members' distress (Wright and Bell 2003).

These affective-oriented communications embedded in close relationships can be intensified further in HVSCs, where features of online communications such as asynchronous interaction and the lack of nonverbal cues facilitate "hyper-personal" communications (Walther 1996). Specifically, through the "intensification loop" of message senders' self-selective disclosure and receivers' idealization of others, online relationships can be more intimate than offline counterparts, and online interactions can involve more disclosure of private thoughts and emotions, leading to increased trust among interactants (Jiang et al. 2011; Tidwell and Walther 2002). This hyper-personal phenomenon is especially important in HVSCs since they are characterized by high homophily and high levels of social identification (Wright 2000, 2015). In such situations, individuals may put more effort toward sharing emotional substance as well as toward providing emotional support.

Relational capital is also expected to be positively associated with individual participation in companionship activities. Close relationships in HVSCs create a foundation for diverse companionship events to materialize. It is often a basis for providing positive inputs to individual well-being such as recreation, humor, and affection, regardless of the presence of stressors (Rook 1987). When stressors are absent, such com-

panionship participation for fun and enjoyment allow people in close relationships to share and engage in conversations about personal information, values, beliefs, and ideas, and identify similarities among themselves (Barnes and Duck 1994). Spending time together and engaging in companionship activities help community participants to maintain relationships, or they may even talk for talk's sake (Barnes and Duck 1994). Through relationship maintenance via participating in companionship activities, community members with high levels of relational capital may continue to remain in the HVSC, even after their problems have been solved (Wang et al. 2014). On the other hand, when individuals face stressful situations, those with high relational capital will tend to engage in companionship activities as a way to cope with health issues and to improve their well-being. By interacting about non-stressor-related topics, individuals orient and "defocus" their attention away from their own health issues (Barnes and Duck 1994). Based on the above discussions, we hypothesize:

**Hypothesis 2a:** Relational capital is positively associated with the provision of informational support in HVSCs.

**Hypothesis 2b:** Relational capital is positively associated with the provision of emotional support in HVSCs.

**Hypothesis 2c:** Relational capital is positively associated with participation in companionship activities in HVSCs.

### **Cognitive Capital, Support Provision, and Companionship Activities**

Interpersonal exchange of resources is more likely to occur when one has the requisite ability to interpret the other's needs, evaluate the context of exchange, and know what and how to share (Adler and Kwon 2002). People facing health-related issues typically join HVSCs because their offline networks lack requisite knowledge (Shaw et al. 2000; Wright and Bell 2003). Cognitive capital as resources providing shared understanding and meanings include shared language and domain-specific expertise (Nahapiet and Ghoshal 1998; Wasko and Faraj 2005). *Shared language* is the aspect of cognitive capital concerning the mastery of community-specific terminologies. It is the means by which people communicate and create a common culture assuring that every utterance has an agreed meaning (Argyle 1967). Virtual communities such as HVSCs create and use shared language, which facilitates collective actions (Laroche et al. 2012). Further, shared language creates an atmosphere encouraging

interpersonal exchange as it eases communication among individuals (Bolino et al. 2002; Luring and Selmer 2011). Shared language is particularly important in defining the actions of members of virtual communities because of their dependence on written texts (Haythornthwaite 2007). In the context of HVSCs, the use of community-specific language is key to presenting oneself as a legitimate member of the community and to exchanging support (Galegher et al. 1998).

*Domain-specific expertise* concerns a knowledge of the content of exchange, which arises from the internalization of interpretive schemas: mental constructs allowing one to create meaning and make sense of a knowledge domain through experience (Ranson et al. 1980). Within a group, domain-specific expertise is also recreated through social interactions by which individuals coordinate and accommodate alternative schemas of members (Lang 2001). As an individual's level of domain-specific expertise increases, so does his/her capacity for effective actions, as it provides him/her with abilities to correctly interpret a context, and to respond appropriately (Brown and Duguid 2001). Domain expertise has been found to be critical for individuals to make online contributions (e.g., Ardichvili et al. 2003).

Healthcare-related expertise as well as the language of the healthcare issue-specific community are especially relevant components of cognitive capital in the context of HVSCs (Barak et al. 2008) because participants of HVSCs are normally not experts on healthcare-related issues, at least initially (Wright and Bell 2003). Specifically, in order to interact effectively and provide help on HVSCs, members must use common healthcare- and community-related language and share healthcare-related expertise. In fact, one key reason for why people facing stressful events are attracted to HVSCs for support, rather than healthcare professionals or their family members, is because HVSC members understand, and can thus help each other based on their shared language and health experience-related expertise: personal healthcare experiences, treatments and side effects, and coping strategies (Barak et al. 2008; Wright and Bell 2003).

We argue that, in an HVSC, individuals' levels of cognitive capital (shared language and healthcare-related expertise) are critical for them to provide informational support. Cognitive capital equips one with the knowledge required to understand other community members' context-relevant needs (Mao and Benbasat 2000) and thus enables one to provide informational support to help solve current problems. Members with high stressor-related expertise are also more likely to contribute their knowledge because they have more information (past medication experiences, survival stories, etc.) to share, possess the required expertise to help, and are in a better position to sense other community members' urgent needs (Mao

and Benbasat 2000). Further, these members are likely to provide informational support since their sense of empowerment will be reinforced through taking the role of guide and helper and through demonstrating that they possess valuable health-related information and experience (Barak et al. 2008; van Uden-Kraan et al. 2008).

Familiarity with the terminology and rituals used in virtual communities, including HVSCs, and a feeling of possessing required knowledge is associated with participation and informational sharing (Nonnecke and Preece 2003). In specialized virtual communities, like HVSCs, the use of community-specific jargon reduces communication costs and increases communication efficiency (Butler 2001). Cognitive capital also reduces the concern about “losing face” by providing wrong information in virtual communities, and thus one will feel more comfortable about contributing one’s expertise (Ardichvili et al. 2003). Moreover, in the context of HVSCs, it is especially important to provide adequate and correct information since the health of individuals might depend on it. The mastery of community-specific vocabularies and jargon facilitates the provision of informational support because the provider will use the appropriate language and will be reassured that support receivers will understand the information (Goodman and Darr 1998).

We also expect that in HVSCs, cognitive capital will be positively associated with the provision of emotional support. In HVSCs, having stressor-related knowledge and experience, and common language that is understandable by those experiencing similar situations, allow one to relate to distressed community members in HVSCs. Many of these experiences and related knowledge are outside the expertise of family members and even healthcare professionals, who might not understand the situation and feelings of community members, as they may not have faced similar situations themselves (Wright and Bell 2003). Therefore, those with high levels of cognitive capital, acquired through personal experience or interacting with others, are more likely to provide emotional support to acknowledge and validate other members’ pain and feelings, emphasize the similarity of their own experience, convey love and encouragement, or even commiserate with other community members (Braithwaite et al. 1999; Håkansson and Montgomery 2003). Further, according to Rimé et al. (1991), after emotional circumstances, people tend to share those emotional experiences with others, in a socially shared language. As a result, those with a mastery of the community shared language are more likely to make sense of received emotion expressions and vividly empathize with other community members’ experiences and provide support. The higher one’s level of cognitive capital, the more one is capable of understanding and relating to other community members’ situations and emotions, and therefore the more one

is likely to provide emotional support. Based on the above discussion, we hypothesize:<sup>5</sup>

**Hypothesis 3a:** Cognitive capital is positively associated with the provision of informational support in HVSCs.

**Hypothesis 3b:** Cognitive capital is positively associated with the provision of emotional support in HVSCs.

### ***Associations among the Social Capital Dimensions***

In addition to the relationships hypothesized above, the existing IS and management literature also suggest positive associations among the social capital dimensions (e.g., Karahanna and Preston 2013). We hypothesize the relationships among social capital components in order to examine their indirect effects on support provision and companionship activities in HVSCs.

Structural capital is expected to be positively associated with cognitive capital. In a HVSC, individuals with high levels of structural capital (or embeddedness) are at the center of communication flows and knowledge exchange (Wellman and Gulia 1999) and are therefore able to learn from connected parties (Wellman and Gulia 1999; Wright and Bell 2003). Research in various disciplines, including management and sociology, has long acknowledged the importance of social interaction for the transfer of knowledge (e.g., Nonaka 1994). Social interactions also help community members acquire community-specific language (Bolino et al. 2002) through the “interactive alignment” of meanings (Garrod and Pickering 2004). In virtual communities such as HVSCs, where community members’ diverse information and perspectives are brought together, new ideas and understandings are also more

<sup>5</sup>We do not hypothesize a relationship between cognitive capital and companionship activities since we did not find evidence or strong theoretical support in the literature suggesting such a relationship. As opposed to informational and emotional support which require requisite knowledge in order to communicate and make sense of messages exchanged, the sharing of jokes, life events, or merely chat (companionship activities) do not necessarily impose expertise requirements on the interactants. Instead, such socializing outside the context of health-/stressor-related issues relies on everyday common-sense knowledge, which is a sociocultural universal (Gardiner 2006). In other words, members of HVSCs should be able to participate in companionship activities regardless of their levels of expertise (i.e., cognitive capital in the context of HVSCs). Other studies on social networking sites have also investigated and highlighted the significance of structural and relational aspects of social capital, but not cognitive capital, and their associations with the use of social networking sites for socializing everyday events (e.g., Ellison et al. 2007).

likely to emerge through interactions (Nambisan and Baron 2009). People join HVSCs soon after they are diagnosed with healthcare-related issues because they feel uncertain about the future, lack the requisite knowledge to understand their own situation, and would need to acquire the related language to facilitate their communications with healthcare professionals. Interacting with other members experiencing similar situations, through a wide variety of informational and emotional support and companionship activities, will help achieve their goals (Barak et al. 2008).

We also expect structural capital to positively influence relational capital. Social interactions are the basis for interpersonal attraction and relational intimacy (Bolino et al. 2002). Reis and Shaver (1988) conceptualized intimate relationships and social bonds as “digested” products of interactions via interpersonal processes such as trust and social identification. In online environments such as HVSCs, where participants lack visual, verbal, and other physical cues present in face-to-face environments, message interaction is key for individuals to evaluate each other’s trustworthiness, build and maintain social identity and a sense of homophily, and construct community norms of appropriate and inappropriate behaviors (Postmes et al. 2000). This relationship building process is further intensified through increased self-disclosure, via both the hyper-personal communications sustained by online environments (Jiang et al. 2011, Tidwell and Walther 2002) and the high urgency and uncertainty context characterizing HVSCs, resulting in intimate and trusted online relationships. In virtual communities like HVSCs, members who are highly embedded structurally tend to perceive interpersonal similarities based on salient characteristics of the community, which fosters group identification and attachment (Postmes et al. 2005).

Finally, we expect that cognitive capital will be positively associated with relational capital. Members of a HVSC are normally sufferers or survivors of similar stressful situations, with a common fate of experiencing the stressor and a common goal of its removal (Wright and Bell 2003). Cognitive capital provides one with the capacity to understand other community members’ situations and to contribute to the community, which in turn allows the community members to value and strengthen their community membership (Fayard and DeSanctis 2010). Additionally, the use of shared language, a unifying symbol, among community members helps define and organize social categories for people to identify with and distinguish group members from nonmembers (Haythornthwaite 2007). It also reflects community members’ conformance to group norms (Postmes et al. 2000). The enactment of shared language via social interactions is particularly critical for creating social identity in online contexts since there are no other symbolic artifacts available for them

to identify with (Fayard and DeSanctis 2010). In communities with high homophily such as HVSCs, the acquisition of knowledge about other members, and the use of common language among community members, can further foster the identification process, thus increasing relational capital. Thus, we hypothesize:

**Hypothesis 4:** Structural capital is positively associated with cognitive capital.

**Hypothesis 5:** Structural capital is positively associated with relational capital.

**Hypothesis 6:** Cognitive capital is positively associated with relational capital.

## Method

Many of the extant IS studies on online helping behavior used self-reported survey questionnaires to capture individual online contribution activities (e.g., Chiu et al. 2006; Zhao et al. 2013). While valid, this approach is susceptible to biases associated with subjective measurements (e.g., Collopy 1996). It is also possible that in the context of virtual communities, data can be biased when individuals inadvertently overestimate their own contributions when they notice a high volume of communication activities (as is the case in other contexts such as electronic brainstorming; Pinsonneault et al. 1999). To address this issue and to complement the evidence collected from past research, we use content analysis to generate objective data regarding online contribution behaviors. Premised on the idea that words and phrases mentioned most often are reflections of important concerns in every communication (Krippendorff 2004), content analysis enables the assessment of rich meaning associated with the content of communication to acquire deep insights into the values, beliefs, attitudes, intentions and behaviors of an individual or a collectivity (Duriau et al. 2007). In the context of social support studies, Collins and Feeney (2000) also suggested that self-report studies must be supplemented by observational studies that examine the interpersonal nature of the social support process as it unfolds in dyadic interactions. Deeper insights into the online social support process can therefore be expected from the analyses of individuals’ actual interaction behavior in this study.

## Data Collection

The target HVSC is a large U.S. based online cancer support community. It hosts discussion boards for various kinds of

cancers and has more than a 100,000 registered members posting hundreds of messages to these boards every day. The three most active discussion boards of this community—colorectal, breast, and prostate cancer discussion boards—were chosen as the data source from which messages were collected. Discussion threads initiated within four time periods (May 2011 and October 2011; June 1, 2012, through August 31, 2012; and September 1, 2012, through November 30, 2012) were downloaded using a web crawler. These collected message threads pertain to three separate data sets. Information about the three data sets is presented in Table 1. Participants of this study were derived from the second data set, and their memberships based on their unique user ID. In order to have a complete record of the individual behaviors taking place across the three-month period, from June 1 to August 31, and to see the outcome behaviors of those individuals, we eliminated those who registered during this period, as well as those who were inactive during the third dataset period, resulting in a sample of 387 members. Our aim is to study the relationship between the social characteristics of these 387 members in terms of their structural, relational, and cognitive capital manifestations, and their subsequent provision of informational support, emotional support, and companionship activities (derived from the third data set).

## Data Analysis

Two coders<sup>6</sup> manually and independently analyzed the 266 threads in the first data set and classified them into message threads initiated either for social support exchange or for companionship activities (i.e., for fun, relaxation, and the enjoyment of being together, Rook 1987).<sup>7</sup> Cohen's (1960) Kappa was used to measure inter-coder reliability, resulting in a value of .86. Disagreements were resolved through discussion. This resulted in 91 message threads that were categorized as companionship activities and 175 threads for

support exchange.<sup>8</sup> The subsequent task focused on manually classifying the 1,996 messages in these 175 social support threads into types of social support. That is, each of these messages was manually classified into those for either informational or emotional support. The resulting inter-coder reliability was .90.<sup>9</sup>

Following Huang et al.'s (2010) procedure, these coded messages were applied to "train" the computer program that incorporated a machine learning algorithm to classify the two types of support messages automatically, resulting in three trained programs (the classifiers) capable of classifying support messages in the three discussion boards, respectively. The 10-fold cross-validation method (Sebastiani 2002) was used to evaluate the classifiers, yielding an average classification accuracy of 92.48%, 94.84%, and 88.01%, for the messages in the breast, prostate, and colorectal cancer discussion boards, respectively. The content analysis tasks are illustrated in Appendix B.

The process described above was repeated for the second and third datasets. That is, first the total of 2,271 threads from the two datasets were manually classified into threads for either support or companionship purpose. Then, to classify the support messages into the two types of social support, due to the large number of social support messages involved (second data set: 9,278 messages, third data set: 9,282 messages), the previously trained automated support classifier was applied. Table 2 summarizes the results of (manual and automatic) classification in each data set. To further examine the robustness of the trained classifier in classifying support messages, we randomly selected 100 support messages from the second and third datasets, classified them manually, and compared the results to the result of automated classification. This yielded a 84% accuracy rate for the automated classifier. Based on these results, the independent and dependent variables used for testing the hypotheses, as summarized in Appendix C, were generated, and the proposed model was tested.

<sup>6</sup> One of the two coders registered with the target cancer community and has been reviewing the online postings for over five years and therefore has a fairly good understanding of the social interactions in the community. The other coder is a Ph.D. student and was trained by this coder to conduct manual classification.

<sup>7</sup> To classify message threads into the two types of activities (social support and companionship activities), only the first message of each message thread was analyzed. This strategy was undertaken due to the nature of online threaded discussions in which the first message of a thread sets up a discussion topic and the conversation that follows is supposed to revolve around this topic.

<sup>8</sup> An example of companionship activities identified through this study is: "The Game Is Back! I thought I'd put this simple game back up, so, play along if you want. All you have to do is change one of the letters in the previous word posted and post your new word. My word is LEAD."

<sup>9</sup> If more than one support type was provided in a message, the predominant one was coded, in order to capture the primary intention and focus of message posters during message composition (Finn 1999). An example of an informational support message is illustrated here: "An hour before your test you will be injected with a radioactive glucose solution. The glucose will be gobbled up by cancer cells and will 'light up' on the PET scan. By not consuming any carbs 24 hours before the test, the cancer cells are more likely to take the bait (so to speak). I hope this helps." An example of an emotional support message is: "You sure are a Survivor! Everyone on this site is, from the cboard to every other board on this site. Hugs, ynz0 a survivor."

**Table 1. Information about Messages Collected for this Study**

Dataset	Purpose	Description	Number of Messages
May 2011 and October 2011	Data for training the automated text classifier	The collection of data spanning two different time periods (May and October 2011) allowed us to account for possible behavioral differences across different seasons (Ahuja et al. 2003). The number of collected messages provided a balance between the efforts required to conduct manual analysis, the generation of meaningful data for training the automated text classifier, and the collection of data large enough to be representative.	2,995 (266 threads)
June 2012 through August 2012	Generating independent variables	As with Chang et al. (2011) and Wasko and Faraj (2005), data for testing the proposed model was collected from two time periods to address the mutual-dependence issue between the independent and dependent variables. Specifically, the messages used for generating independent variables were those that were posted during a three months period prior to when the messages that were used for generating dependent variables were posted. This helps ensure the causal direction to be tested in the proposed model.	14,677 (1,149 threads)
September 2012 through November 2012	Generating dependent variables		14,461 (1,122 threads)

**Table 2. Results of Message Classification**

Dataset	Total Number of Messages	Companionship Activities	Informational Support	Emotional Support
May 2011 and October 2011	2,995 messages (266 threads)	999 messages	1,171 messages	825 messages
June 2012 through August 2012	14,677 messages (1,149 threads)	5,399 messages	4,084 messages (Auto Classification)	5,194 messages (Auto Classification)
September 2012 through November 2012	14,461 messages (1,122 threads)	5,179 messages	3,489 messages (Auto Classification)	5,793 messages (Auto Classification)

### Independent Variables

Many IS studies on the determinants of social support adopted Nahapiet and Ghoshal's (1998) social capital framework as their theoretical basis (e.g., Robert et al. 2008; Wasko and Faraj 2005), which highlights the multidimensionality of both social capital as well as the social capital dimensions themselves. There is, however, a lack of consensus on how to operationalize social capital and its dimensions (structural, relational, cognitive; see Appendix A). For instance, Lu and Yang (2011) and Robert et al. (2008) modeled and measured the three social capital dimensions reflectively by their components such as norms, identification, and shared language. Because structural, relational, and cognitive capital do not exist independent of their components, and these components are not conceptually interchangeable, modeling these constructs as formative is more appropriate (Coltman et al. 2008). Other studies have conceptualized structural, relational, and cognitive capital directly as their components such as trust

and expertise, and have examined their direct effects on information sharing behaviors (e.g., Chang and Chuang 2011; Chiu et al. 2006; Zhao et al. 2013). However, this approach creates conceptual and empirical ambiguity because it precludes extrapolation at the level of the dimensions of social capital (i.e., structural, cognitive, relational) since the links between the dimensions and their components are not specified (Law et al. 1998). Unless conceptualizations and empirical analyses are conducted at the level of structural, relational, and cognitive capital dimensions, it is difficult to draw conclusions about the relationships between them and the outcome variables. In contrast to these prior practices, we adopted the hierarchical modeling approach (Wetzels et al. 2009) in order to both capture the multifaceted nature of these social capital dimensions and maintain model parsimony in interpreting and generalizing the findings.

In our study, *structural capital* was measured by its three key structural characteristics: frequency, intensity, and multi-

plexity (Adler and Kwon 2002). Specifically, three first-order constructs representing these three structural characteristics were created to capture and form a given community member's levels of structural capital, which is modeled as a second-order construct. Since these components conceptually tap into different aspects of structural capital, and they are not expected to necessarily covary (Petter et al. 2007), making these constructs formative is appropriate. As discussed in the hypotheses section, in the context of HVSCs, where community members tend to have volatile participation patterns (initial bursts of activity that subsequently decline), an individual with high levels of structural capital, reflected by their intensity, frequency, and multiplexity of interactions, will have more opportunities to provide informational and emotional support, and participate in companionship activities. Each of these first-order constructs was measured by a single indicator that was calculated based on HVSC members' participation behavior (see Appendix C for details).

*Relational capital* was also conceptualized as a higher-order formative construct with three first-order constructs as its components: social norms, social identity, and trust. To assess the degree to which one internalizes the shared group norms and behaves accordingly, we identified the norm of being supportive as the relevant indicator in the context of HVSCs. As pointed out earlier, the norm of being supportive is prevalent in HVSCs where emotion and urgent needs abound. In this study, the norm of being supportive was measured by two reflective indicators that capture the degree to which one is responsive to discussion threads initiated by other members. Social identity was measured formatively by two indicators, in-group liking and favorable in-group evaluation, which respectively represent the affective and evaluative aspects of social identity (Bergami and Bagozzi 2000; Ellemers et al. 1999).<sup>10</sup> The high homophily and attachment nature of HVSCs make these two indicators appropriate. To assess an individual's trust toward the HVSC and its members, the level of self-disclosure in his/her support messages was measured (Grabner-Kräuter 2009).

*Cognitive capital* was modeled as a second-order formative construct with two first-order constructs: shared language and healthcare-related expertise. To assess the level of shared language, two reflective indicators were created based on the patterns of word usages by members of the same community. Specifically, for each community member, the degree to which s/he used shared language in his/her messages was cal-

culated by (1) the level of similarity of his/her messages to the community-specific prototypical message created via the term-frequency-inverse-document-frequency (*tf-idf*) weighting approach (Baeza-Yates 1999) that represents the shared behavior of using common words and terminologies in messages within the community, and (2) using the Latent Dirichlet Allocation model (Blei 2012; Wu 2013) to identify and calculate the extent to which a community member's usage of words and terminologies covers different discussion themes of the community. Additionally, community members' level of use of the unified medical language system (Bodenreider 2004) semantic types in support messages was used to assess their level of healthcare-related expertise.

## Dependent Variables

Individual provision of informational support and emotional support and participation in companionship activities are the three dependent variables in this study. For each construct, two reflective indicators were used: total number and total length of messages sent by a member.<sup>11</sup>

## Results

To test the model and hypotheses, partial least squares (PLS) was used. We chose PLS since it is appropriate for analyzing models that contain both formative and reflective indicators (Chin and Newsted 1999). Additionally, the focus of PLS on predictive modeling aligns with the objective of our study. SmartPLS 2.0 (Ringle et al. 2005) was used for data analysis.<sup>12</sup> To model the hierarchical structural model, we followed Becker et al.'s (2012) and Wetzels et al.'s (2009) guidelines and used a repeated indicator approach with formative measurement (mode B) for the repeated indicators to construct the higher-order latent variables.

## Measurement Model Validation

The first step of our analysis tested the adequacy of the measurement model. For reflective indicators, we assessed their

<sup>10</sup>A third aspect of social identity, cognitive identification, stands for one's cognitive awareness of one's membership in a group (Ellemers et al. 1999). According to Bergami and Bagozzi (2000), affective and evaluative identification fully mediate the effect of cognitive identification on individual helping behavior.

<sup>11</sup>In calculating the dependent variables, we did not consider the first messages in support threads. This heuristic was performed due to the fact regarding threaded discussions that the first messages in social support threads are normally support requests.

<sup>12</sup>A bootstrapping procedure (500 resamples, as recommended by Mooney and Duval 1993) was used to assess the significance level of the hypothesized paths.

**Table 3. Factor Loadings and Cross-Loadings (of Reflective Constructs)**

	Norm	Trust	Shared Language	Informational Support	Emotional Support	Companionship
NM1	0.71	0.12	0.17	0.22	0.16	0.16
NM2	0.92	0.20	0.27	0.31	0.36	0.36
TR1	0.20	0.78	0.48	0.18	0.24	0.19
TR2	0.11	0.76	0.55	0.14	0.26	0.23
SL1	0.34	0.61	0.93	0.57	0.56	0.56
SL2	0.09	0.56	0.80	0.21	0.28	0.24
INFO1	0.33	0.23	0.51	0.98	0.61	0.75
INFO2	0.31	0.18	0.45	0.98	0.49	0.72
EMO1	0.32	0.33	0.50	0.52	0.99	0.71
EMO2	0.35	0.31	0.51	0.59	0.99	0.72
COMP1	0.35	0.29	0.50	0.64	0.77	0.96
COMP2	0.30	0.23	0.45	0.81	0.59	0.94

**Table 4. Descriptive Statistics, AVE, CR, and Correlations**

	AVE	CR	1	2	3	4	5	6	7	8	9	10	11
Frequency	N/A	N/A	N/A										
Intensity	N/A	N/A	0.06	N/A									
Multiplexity	N/A	N/A	0.47	0.08	N/A								
Shared Norm	0.68	0.81	0.51	0.04	0.25	0.82							
Trust	0.59	0.74	0.35	0.18	0.54	0.20	0.77						
Social Identity	N/A	N/A	0.32	0.13	0.31	0.12	0.18	N/A					
Shared Language	0.75	0.86	0.55	0.24	0.69	0.28	0.67	0.31	0.87				
Expertise	N/A	N/A	0.62	0.15	0.56	0.38	0.54	0.28	0.78	N/A			
Informational Support	0.96	0.98	0.47	0.11	0.34	0.33	0.21	0.30	0.49	0.70	0.98		
Emotional Support	0.97	0.99	0.54	0.14	0.46	0.34	0.33	0.37	0.51	0.58	0.56	0.98	
Companionship	0.9	0.95	0.54	0.22	0.47	0.34	0.27	0.37	0.50	0.64	0.75	0.72	0.95

indicator reliability, convergent validity, internal consistency reliability, and discriminant validity. Table 3 shows the factor loadings and cross-loadings of the reflective indicators, in which the loadings of the indicators for the informational and emotional support provision constructs are greater than the generally accepted 0.7 threshold. This suggests indicator reliability. Convergent validity of the constructs was assessed via average variance extracted (AVE), with a threshold of 0.5 (Fornell and Larcker 1981). Internal consistency reliability of the indicators for each construct was examined using composite reliability (CR), with 0.7 as an acceptable value (Fornell and Larcker 1981). Table 4 summarizes the measurement model results, which suggest that our proposed model meets all these criteria. Discriminant validity was tested by calculating the square roots of the AVE for each construct and

comparing them to the corresponding inter-construct correlations (Fornell and Larcker 1981). As Table 4 shows, all the square roots of AVE (diagonal elements) exceed the correlations in corresponding rows and columns, suggesting discriminant validity (considering constructs with reflective indicators only). In addition, each indicator in Table 3 has a factor loading that is greater than the corresponding cross-loadings by at least 0.1 (Wixom and Todd 2005), providing further evidence of discriminant validity (Chin 1998).

Regarding model validity and reliability of the formative constructs, we assessed their indicator validity and tested for multicollinearity (Petter et al. 2007). First the path weights of the formative indicators were examined (Chin 1998). The results showed that the weights are all significant at the 0.01



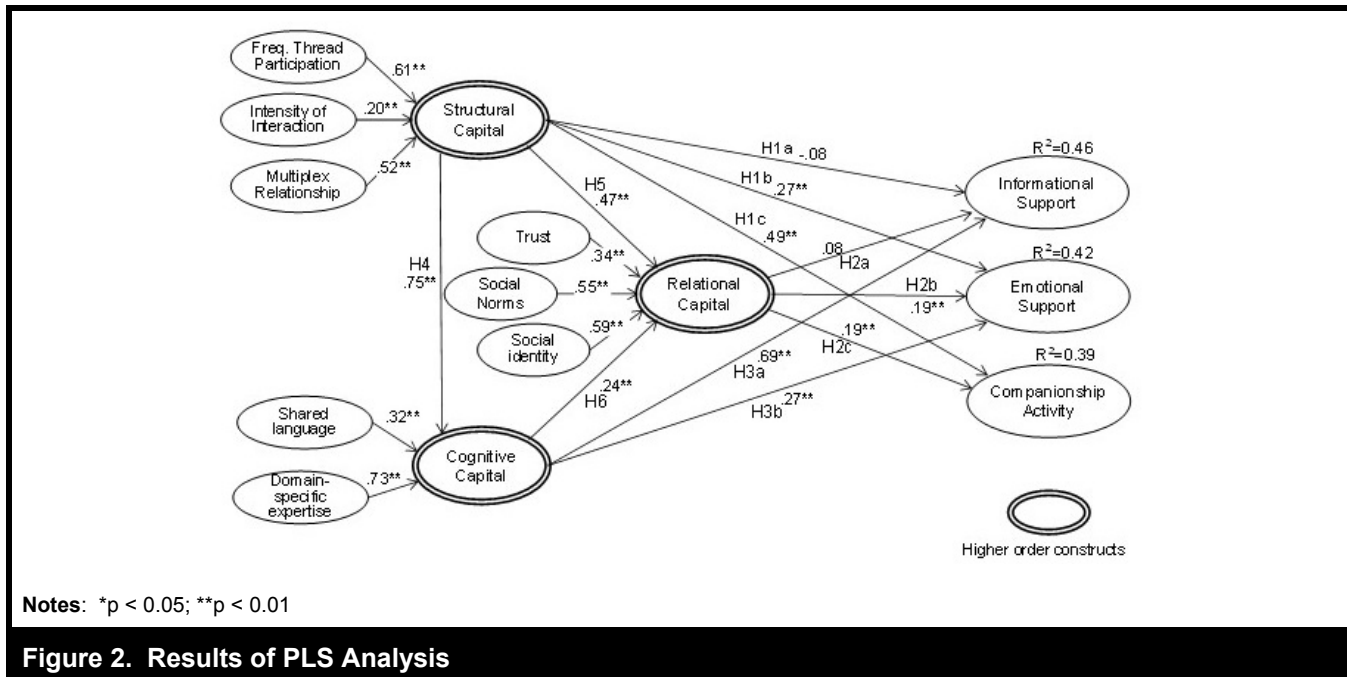


Figure 2. Results of PLS Analysis

level, suggesting the validity of those measurements (see Figure 2). Likewise, the path weights of the lower-order constructs are significant formative indicators of their respective higher-order ones. Multicollinearity can be a concern in our model due to the high correlation between the two formative measures of cognitive capital (0.78, see Table 4). This high correlation between the two constructs was expected since one's healthcare-related expertise is also about the ability to use language of the healthcare domain. However, shared language of a HVSC is more than just healthcare-related terminologies. It also involves jargon belonging specifically to the community and not shared with others (e.g., "pink bus" in the breast cancer discussion board). VIF (variance inflator factor) was used to assess multicollinearity. The resulting values range from 1.01 (formative indicators of shared identity) to 2.56 (formative constructs of cognitive capital), which are lower than the 3.3 cut-off threshold (Petter et al. 2007). This suggests the absence of multicollinearity and that all the formative measures capture different aspects of their corresponding constructs.

Our data for measuring different social relationship characteristics (i.e., social capital dimensions) were collected from the same time period. As a result, common method variance (CMV) may potentially bias the results regarding the associations among them (Podsakoff et al. 2003). Two methods were used to assess CMV. Harman's single-factor test was first performed (Podsakoff et al. 2003), and the result showed that no single factor could explain most of the variance among the

variables (the first factor accounted for 36% of the variance). Additionally, we also applied the correlational marker technique (Lindell and Whitney 2001; Richardson et al. 2009) and followed Lindell and Whitney's (2001) and Malhotra et al.'s (2006) *post hoc* approach to choose the second-smallest positive correlation between two manifest variables (0.01) as a proxy for CMV. By examining the CMV-adjusted correlations among latent constructs, we found that the significance levels of all but one of the correlations remain unchanged, suggesting CMV is unlikely to be a concern in our study (Malhotra et al. 2006).

### Structural Model Testing

Figure 2 shows that 42% of the variance in emotional support provision, 46% of the variance in informational support provision, and 39% of the variance in companionship activity were explained by the proposed model. As for the hypotheses, structural capital was not significantly related to the provision of informational support (H1a was not supported). Likewise, H2a was not supported (i.e., relational capital was not related to informational support provision). On the other hand, as expected in H3a, cognitive capital was found to be positively associated with the provision of informational support ( $\beta = 0.69$ ,  $P < 0.01$ ). The three dimensions of social capital were also positively significantly related to the provision of emotional support: structural capital (H1b,  $\beta = 0.27$ ,  $P < 0.01$ ), relational capital (H2b,  $\beta = 0.19$ ,  $P < 0.01$ ), and

**Table 5. Results of PLS Analysis**

Hypotheses	From	To	$\beta$	t-statistic	Supported?
H1a	Structural Capital	Informational Support	-0.08	1.15	Not Supported
H1b	Structural Capital	Emotional Support	0.27**	3.82	Supported
H1c	Structural Capital	Companionship Activity	0.49**	8.49	Supported
H2a	Relational Capital	Informational Support	0.08	0.90	Not Supported
H2b	Relational Capital	Emotional Support	0.19**	3.19	Supported
H2c	Relational Capital	Companionship Activity	0.19**	2.71	Supported
H3a	Cognitive Capital	Informational Support	0.69**	13.67	Supported
H3b	Cognitive Capital	Emotional Support	0.27**	4.13	Supported
H4	Structural Capital	Cognitive Capital	0.75**	31.33	Supported
H5	Structural Capital	Relational Capital	0.47**	5.88	Supported
H6	Cognitive Capital	Relational Capital	0.24**	3.98	Supported

**Table 6. Summary of Total Effects**

From	To	Direct Effect	Indirect Effect	Total Effect
Structural Capital	Cognitive Capital	0.75**	N/A	0.75**
Structural Capital	Relational Capital	0.47**	0.18**	0.65**
Cognitive Capital	Relational Capital	0.24**	N/A	0.24**
Structural Capital	Informational Support	-0.08	0.57**	0.48**
	Emotional Support	0.27**	0.33**	0.60**
	Companionship Activity	0.49**	0.12*	0.61**
Relational Capital	Informational Support	0.08	N/A	0.08
	Emotional Support	0.19**		0.19**
	Companionship Activity	0.19**		0.19**
Cognitive Capital	Informational Support	0.69**	0.02	0.71**
	Emotional Support	0.27**	0.04**	0.31**
	Companionship Activity	N/A	0.04*	0.04*

Notes: \* $p < 0.05$ ; \*\* $p < 0.01$

cognitive capital (H3b,  $\beta = 0.27$ ,  $P < 0.01$ ). Finally, as hypothesized, both structural and relational capital were significantly related to companionship activities (H1c,  $\beta = 0.49$ ,  $P < 0.01$  and H2c,  $\beta = 0.19$ ,  $P < 0.01$ , respectively).

Hypotheses regarding the associations between structural capital and the other two social capital dimensions (H4 and H5) were supported as predicted. Specifically, structural capital was positively associated with both cognitive capital (H4,  $\beta = 0.75$ ,  $P < 0.01$ ) and relational capital (H5,  $\beta = 0.47$ ,  $P < 0.01$ ). Similarly, the hypothesized positive relationship between cognitive capital and relational capital was supported (H6,  $\beta = 0.24$ ,  $P < 0.01$ ). Table 5 summarizes the findings of this study.

Table 6 summarizes the effects of the social capital dimensions, including the cumulative effects of the direct and mediated effects. (For details of the mediation analysis, see Appendix D.) As Table 6 shows, structural capital had the strongest total effects on the provisions of emotional support and companionship activities, and cognitive capital had the highest total effect on informational support. Furthermore, while structural capital was not directly associated with the informational support provision, it had a strong, indirect impact on the offerings of this support type ( $\beta = 0.57$ ,  $P < 0.01$ ), presumably mainly through cognitive capital. Finally, mediation analysis showed that there is a weak, but significant mediation effect between cognitive capital and companionship through relational capital.

## Discussion

By addressing the research question (How do cognitive, structural, and relational dimensions of social capital impact the provision of informational and emotional support and engagement in companionship activities in HVSCs?), our study is among the first to examine the antecedents of three types of social behaviors in HVSCs. Our findings show that in addition to information support, emotional support and companionship activities play major roles in HVSCs, which sets HVSCs apart from other virtual communities dominated by informational support, which have been the main focus of the IS literature heretofore. For community members to benefit from social support and companionship activities, and for a HVSC to be sustainable, it is therefore critical to explore how to motivate and provide opportunities for these members to participate and make these different contributions.

Our findings support the argument that different support behaviors may be activated under different conditions, as was the case for other healthcare communities (Gray et al. 1996; Wellman and Wortley 1990). Specifically, while the three social capital dimensions significantly influence the community members' provisions of emotional support and companionship activities, only cognitive capital positively influences individual offerings of informational support. Additionally, our findings show that structural and cognitive capital have stronger effects on emotional support, compared to relational capital (0.27 versus 0.19), and the effect of structural capital on companionship activity participation is stronger than that of relational capital (0.49 versus 0.19). These results suggest that in HVSCs, one's social connections (who you know), and expertise and shared language (what you know) contribute more to one's helping behavior than one's relational embeddedness in the community (relationship strength). Specifically, the results imply that HVSC participation may be more dependent on the opportunity and ability to provide support and/or participate in companionship activities, than on the relational motivation to do so. When those high in structural capital provide social support and participate in companionship activities, it can further increase their opportunity to receive valuable healthcare information. Additionally, people with high cognitive capital might continue to interact with others in order to further enhance their expertise, or they may continue to provide support so as to be treated by support recipients as role models (Taylor and Lobel 1989). Instrumental factors like these might lie behind the difference in strength of effects on social support and companionship activities between structural, cognitive, and relational capital.

Consistent with previous studies (e.g., Ahuja and Galvin 2003), structural capital influences other dimensions of social capital. Researchers generally agree that social interactions

are key to the creation of intimate relationships (e.g., Reis and Shaver 1988) and the acquisition of knowledge and expertise (Nonaka 1994). Through increasing the frequency, intensity, and multiplexity of interactions, personal relationships among community members are closer, and community-specific language and healthcare expertise are developed, shared, and acquired. Mediation analyses further showed that relational capital partially mediated the relationship between structural capital and emotional support provision, and between structural capital and companionship activity participation. In addition to its partial mediation effect between structural capital and emotional support, cognitive capital fully mediated structural capital's effect on informational support. This result, together with the finding that cognitive capital has the strongest total effect on informational support provision (see Table 6), suggest the importance of the community's identification of healthcare experts for members of HVSCs seeking to solve health-related problems. The findings also show that structural capital plays a strong indirect role in informational support provision, via the facilitation of cognitive capital. Additionally, the indirect effect of structural capital on emotional support, via the mediations of relational and cognitive capital is slightly stronger than its direct effect. While Nahapiet and Ghoshal (1998) posited that structural capital affects interpersonal resource exchange primarily directly, through its creation of access opportunity, this finding suggests that structural capital in HVSCs facilitates support exchange commensurately, both directly and indirectly through relational and cognitive capital.

Contrary to our hypothesis, there was no direct relationship between structural capital and the provision of informational support, nor did relational capital predict informational support. While these findings are at odds with that of some previous studies (e.g., Chiu et al. 2006; Wasko and Faraj 2005), they support Adler and Kwon's (2002) argument that the existence of access opportunity (structural capital) and relationship intimacy (relational capital) does not guarantee one's contribution of informational help. In other words, voluntary contribution may be less likely to happen if one does not have the requisite ability (cognitive capital) to do so. This can especially be the case in HVSCs where a steep learning curve, or extensive personal experience, may be prerequisites for individuals to acquire healthcare knowledge, such as coping skills, advice on treatments, medication side effects, and so on (Hartzler and Pratt 2011). When a community member asks for information regarding symptoms of a disease or a healthcare provider, potential support providers may be reluctant or unable to help unless they are confident in their knowledge about what and how to provide support.

The significant and positive relationship between cognitive capital and informational support provision is at odds with

some previous studies (e.g., Chiu et al. 2006; Lu and Yang 2011; Park et al. 2014; Wasko and Faraj 2005). Whether or not such a discrepancy may be attributed to the fact that our study was conducted in an HVSC context requires further investigation. This difference in findings can also be attributed to how cognitive capital was measured across studies. Studies like Park et al. (2014) used self-rated expertise as an indicator of this social capital dimension. Since other studies such as Sarker et al. (2011) used a similar measure to capture individual human capital, whether such an indicator is appropriate for measuring cognitive capital is questionable. In this study, we derived the indicators from community members' actual social behaviors, a closer representation of the social nature of this construct.

### **Contributions to Research**

This study makes several contributions to both social support and IS research. First, while online helping behavior has been studied extensively by IS researchers, little is known about the drivers of such behavior in the context of HVSCs. We argued that while similar to other knowledge sharing communities that connect people with similar interests and engage them in interpersonal transactions, HVSCs afford a broader array of social behaviors. By going beyond the extant focus on informational support in IS research on virtual communities, we provide a more integrated view of the impact of social capital by considering its influence on informational and emotional support as well as companionship activities, three main social activities relevant to HVSCs. Showing that characteristics of online social relationships are key drivers of these primary social activities in HVSCs, our study provides a framework for the antecedents of social support and companionship activities that could guide future research in online support. Additionally, this study highlights the importance of companionship activities as an important social activity participated in by HVSC members, which contributes to a third of online supportive interactions. The consideration of companionship activities in HVSCs has been neglected by IS and social support researchers, who often treat this type of activity as unimportant and classify it as unrelated, off-topic, or miscellaneous (Huang et al. 2014). As argued in the theoretical foundation section, companionship activity is as important as social support and they make complementary contributions to individuals' well-being.

Second, by showing the different relationships between the social capital dimensions and the provisions of informational and emotional support and companionship activities, our study also highlights the importance of considering a larger complement of social interactions in virtual communities. For example, while emotional support and companionship activities

may not be as prominent in knowledge-sharing virtual communities as in HVSCs, their considerations can offer alternate explanations to prior findings such as the nonsignificant relationship between relational capital, or its components, and knowledge contribution (e.g., Wasko and Faraj 2005). In addition to concluding that in online settings individuals may engage in knowledge contribution regardless of their levels of affective commitment (Wasko and Faraj 2005), we can further posit that relational capital instead contributes more to individual provisions of caring, empathy, and encouragement (i.e., emotional support) and the exchange of life events, jokes, etc., for relaxation and enjoyment (i.e. companionship activities). Many virtual communities are designed to provide informational help initially and members might not join them with the intent of providing or receiving emotional support. However, emotional support might emerge as the social dynamics of these communities evolve over time. For example, Duncan-Howell (2010) found that nearly 40% of the members of three teachers' knowledge-sharing virtual communities reported that the exchange of emotional support was one of the reasons they maintained community membership. A legal listserv created for lawyers to share information such as practice experiences and skills became a means for exchanging emotional support (Levin 2005). Thus, taking a broader view of the kinds of social activities present in virtual communities seems to reflect reality more accurately. Another potential issue associated with the limited conceptualization of different types of helping behaviors is that the measurement items for information/knowledge sharing, such as number of messages posted, may inadvertently capture emotional support behavior (e.g., Lu and Yang 2011; Park et al. 2014, see Appendix A).

Third, the paper adds to the IS literature on virtual communities and social media that are used in situations that share similarities with HVSCs (i.e., urgency and volatility) such as communities during disasters or crises (e.g., Oh et al. 2013; Pan et al. 2012). In crisis situations, there might be no time to develop relationship and communications networks among virtual community members. Rather, the information flow depends on the nature and strength of ties that already exist in the virtual community (Pan et al. 2012; Xia et al. 2001). Our study can inform research on the effects of existing (such as structural and relational capital) and/or emergent social capital (in particular social identity that arises due to shared experience; Drury et al. 2009) in a given virtual community on the ability of community members to swiftly provide informational and emotional support and companionship to members in need.

Finally, by analyzing online message content, we also complement the extant IS studies on online helping behavior that used self-report data. This study is based on the generation

and test of objective measures reflecting community members' sociopsychological statuses as well as their actual behavior through the use of an automated method to analyze large amounts of user-generated text. In this study, content analysis was applied to classify different types of activities. Based on the premise that word use conveys psychosocial information about an individual (Pennebaker et al. 2003), content analysis helped us adequately measure the levels of social identity, social norms, shared language, and expertise of message posters. Since our data were generated from actual social interaction content of members of the HVSCs, they adequately reflect the different aspects of social relationships and capture the essence of social capital. Furthermore, our adoption of both inductive (discussion topic identification via Latent Dirichlet Allocation) and deductive (social support type classification) text mining approaches in this study provide techniques for facilitating future IS studies on online user-generated content. This will help researchers to explore topics from online interactions for theory building, or to analyze online text automatically with *a priori* theories or concepts in mind. The use of a combination of content analysis and deductive/inductive automated analysis methods could complement or replace manual classification of online content (e.g., Luo et al. 2013; Vaast et al. 2017).

### **Implications for Practice**

Our study contributes to practice in several ways. Our findings highlight the importance of building structural capital in HVSCs. This is not only because structural capital has a strong effect on emotional support provision and companionship activities, but also because it further boosts relational capital and facilitates the creation of cognitive capital. This suggests that, as a community consisting primarily of lay people with little professional healthcare-related expertise, it is crucial to encourage existing and new members to engage in intense, frequent, and multiplex interactions of social support and companionship activities. According to the design guidelines for virtual community usability and sociability proposed by Preece and Shneiderman (2009), this can be achieved by creating visually appealing and well-organized content with clear navigation paths, having community experts update content regularly, and developing community tutorials, video introductions, and frequently asked questions sections. Additionally, inviting healthcare professionals to participate in HVSCs to share useful information and making it easier for members to locate experts will help address the urgent needs of community members and foster interactions (Kummervold et al. 2002; Preece and Shneiderman 2009). Creating a reputation mechanism that identifies top contributors can also encourage member participation (Ma and Agarwal 2007; Preece and Shneiderman 2009).

Moreover, our study suggests that we need to revisit the finding that practitioners should promote the formation of small cliques in virtual communities and engage in intensive interactions to sustain membership contributions (Bock et al. 2015). Our findings suggest that in HVSCs, in addition to participating in intensive interactions, engaging in diverse discussion threads and interacting with a wide range of members, and joining in companionship activities to form multiplex relationships are also key to increasing one's structural capital in the community.

Our study also suggests the importance of increasing social identity, trust, and supportive norms in HVSCs (i.e., increasing relational capital) in order to facilitate emotional support provision and encourage companionship activities. Since participating in HVSCs requires extensive disclosure of personal, sensitive information, community designers and administrators need to assure members about the safety of sharing such personal information. Clear policies highlighting the security of shared information and membership anonymity, and a welcome message showing the clear purpose of the community, intended audience, and information about site managers will increase trust among community members (Preece and Shneiderman 2009). HVSCs are unique because of their homophily and urgency characteristics. The provision of clear information in welcome or "sticky" (messages that are pinned and stay on the top of the message board) messages highlighting and reminding members of the similarities among community members and the importance of being "answer people" for others facing stressful situations will also promote community identification and helping norms (Maloney-Krichmar and Preece 2002; Preece and Shneiderman 2009).

Our study shows that cognitive capital is the sole source of informational support provision in HVSCs. It is therefore essential to equip community members with healthcare and community-related expertise. Studies have found that non-familiarity with the terminology and rituals used in virtual communities, including HVSCs, and a perceived lack of required knowledge to participate contribute to the reasons why people lurk (Nonnecke and Preece 2003). As discussed earlier, encouraging community members, who are typically lay people without professional healthcare expertise, to engage in intense, diverse, and multiplex interactions will build up structural capital, which will in turn lead to the acquisition and development of shared language and healthcare-related expertise. The introduction of experts to a community, together with a system design allowing community members to identify these experts, and regular education webinars can stimulate discussion among community members and encourage knowledge acquisition and creation.

The findings that different types of social support and companionship activities may be influenced by different dimensions of social capital can help practitioners design appropriate interventions to foster provision of the type of support that is more effective and preferable in a given community. For example, the provision of informational support can be encouraged by healthcare organizations seeking to enhance the quality of their offerings through patients' inputs via virtual community initiatives (Füller et al. 2009; Nambisan and Nambisan 2009). This can be achieved through the provision of educational resources for expertise development, or the identification of, and work with, experts in a community, who are, as shown in this study, more likely to provide informational support. Additionally, the offering of emotional support could be stressed and facilitated by HVSCs intended for individuals with low levels of control over the stressors (Cutrona and Russell 1990), such as mental disorders (Yan and Tan 2010). This can be done through the creation of structural capital via, for example, encouraging individual participation in companionship activities. Even for organizations attempting to harvest the "wisdom of crowds" through electronic networks of practice (Wasko and Faraj 2005), where the primary focus is on community members' sharing of knowledge, emotional support should be promoted among community members, as it can lead to employee job satisfaction and affective commitment (Lilius et al. 2011).

Finally, the inductive and deductive text mining techniques developed in this research can also be used by virtual community designers. It allows them to develop automatic capabilities that could identify and push relevant postings and threads to specific members of a community, or matching similar members or members with community experts based on message content, thus increasing communication opportunities and augmenting the value of the community to its members.

### **Limitations and Future Research**

This study has some limitations that could be examined in future research. One limitation is that, for reasons of model parsimony, we chose not to consider the interaction effects among the social capital dimensions, as the impact of a multiplicative model that also involves these interaction effects does not significantly differ from the variance explained by just these dimensions (Siemsen et al. 2008). Nevertheless, we recognize the complexities of interpersonal dynamics and possible mutually reinforcing and undermining effects among the dimensions of social capital, and encourage future investigation of potential interaction effects.

Since our results are based on the cross-sectional examination of online message-posting behaviors, detailed development processes of the social capital dimensions and their effects on each other, and on social support and companionship are missing. A longitudinal or case study that sheds light on such a complex phenomenon would be desirable. Given the relatively nascent stage of theoretical and empirical examination of the antecedents of social support and companionship activity in HVSCs, we developed our research model by drawing on one key theoretical perspective, and used a data collection approach that complements extant IS research. Our model could be supplemented with additional factors (e.g., individual factors such as social and empathetic self-efficacy, contextual factors such as different types of stressors, or system factors such as information quality and system quality) from different theoretical perspectives, and through different data collection approaches (e.g., survey questionnaires) in future research.

It would also be worth investigating to see if our results hold for other types of HVSCs (e.g., non-cancer illness, psychological issues, or pregnancy). Additionally, due to the anonymous nature of the HVSC and the limited demographic information on members, we could not ascertain whether community members in our sample were acting as individuals or institutional representatives or healthcare providers, who may show different behavioral patterns than patient members. However, since our target HVSC is a peer-to-peer social support community, rather than an organization-led community for information sharing and/or gathering purposes, the presence of institutional representatives or healthcare providers should be minimal and should not affect the results of our analysis.

Likewise, due to the anonymous nature of the three communities studied, we cannot be certain about their gender composition, which limits our ability to examine potential gender differences in online social support provision. Previous research on behavioral differences between men and women in HVSCs (e.g., Gefen and Ridings 2005; Gooden and Winefield 2007; Huang et al 2014) suggests that the effects of social capital on members' willingness to provide support and engage in companionship activities might differ by gender. For instance, research suggests that women tend to adopt feeling- and relationship-focused strategies to provide emotional support (Kunkel and Burleson 1999). This requires tightly knit social interaction ties (i.e., structural capital) as well as close relationships (i.e., relational capital). Men, on the contrary, focus more on the problem and situation the support recipient is facing as their strategy for emotional support (Kunkel and Burleson 1999), which requires cognitive capital to make sense of the problem and facilitate the support provision. Future studies should examine patterns of

social support dynamics manifested in HVSCs to see if they differ based on gender. Also, since the HVSC we studied is hosted in the United States, the majority of the data are U.S. based (although some community members are from Asian or European countries). Whether the findings of this study would still hold in HVSCs of different countries is yet to be examined.

As with Chang et al. (2011) and Wasko and Faraj (2005), the data were separated into two time periods to address the mutual-dependence issue between the independent and dependent variables. However, the matching process resulted in some patients being eliminated from the sample due to inactivity. It remains to be seen if there are behavioral differences between patients who stop participating in the HVSC and those who persist. While it was outside the scope of our study, future research could also study the reasons for individuals becoming inactive in HVSCs. For instance, is it due to personal differences, lack of motivation, or limited perceived value of the HVSCs? Further, it would be interesting to study patterns of attrition by analyzing whether attrition occurs soon after initially joining HVSCs or later, and whether they are triggered by certain events or occur continuously and regularly over time. In this study we used a three month period for generating each dataset (independent and dependent variables) and this window size was chosen to ensure that the sample size (number of involved community members and the messages posted by them) were adequate for analysis. Future researchers could perform a sensitivity analysis to see how robust the results are to changes in a specific time window or across different time windows.

We chose not to use centrality measures, such as degree centrality, to measure structural capital, as individuals may show consistent behavioral patterns across time periods that are developed out of routine activities (i.e., habits; Wohn et al. 2012). The high correlation between the degree centrality measure, which is created based on the number of messages posted (Ahuja et al. 2003, Wasko and Faraj 2005) during the time period of the second dataset, and the resulting number of support and companionship messages posted during the time period of the third dataset, can therefore be expected. We also eschewed using betweenness centrality, because HVSCs do not have information gatekeepers who are able to facilitate and/or inhibit communications and the flow of information. However, the existence and impact of central nodes in HVSCs cannot be entirely discounted. Future research can investigate the efficacy of such measures.

Finally, there are some inherent limitations associated with content analysis. The choice of the unit of analysis always involves a compromise between factors such as meaningfulness and efficiency (Krippendorff 2004). For example,

since the level of analysis for the support classification tasks is the whole message, detailed information regarding the existence of, and the degree to which, different types of support are provided within each message is missing. In the same vein, the intentional separation of message threads into threads initiated for support exchange and for companionship activities may over-simplify the real-world complexities of social interaction. Further, an inevitable limitation of conducting automated content analysis using machine learning techniques is the introduction of prediction errors. To compensate for these problems, future studies may employ a mixed-method methodology to triangulate the findings.

## Conclusion

This paper deepens our understanding of individual online social behaviors in HVSCs and broadens our approach to studying other types of virtual communities. While the social dynamics of HVSCs are different from those of other types of virtual communities (e.g., consumer communities), where knowledge and/or information sharing is the primary focus, emotional support might also play a role in those communities. Emotional support, either because it is at the core of the community from its inception like in HVSCs or because it emerges over time, is important for different types of virtual communities and community members and should be studied more.

By integrating informational and emotional support as well as companionship into one theoretical model, our paper answers several questions regarding the antecedents of these three types of online social interactions. As such, it provides a fresh perspective on HVSCs and potentially on other types of virtual communities as well. We hope that our study provides the theoretical foundations for research on support provision and companionship in virtual communities and that it will stimulate research on this important topic.

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## SHARING IS CARING: SOCIAL SUPPORT PROVISION AND COMPANIONSHIP ACTIVITIES IN HEALTHCARE VIRTUAL SUPPORT COMMUNITIES

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## Appendix A

### IS Studies that Adopted Social Capital Theory to Investigate the Determinants of Social Support

Author	Type of helping behavior (social support)	Manifested constructs	Operationalization (when measuring social capital dimensions directly)	Positively predict the provision of social support?	Major findings
<b>Social Capital Dimensions as Predictors</b>					
Lu and Yang 2011	Knowledge and information	Structural capital	Second order reflective construct with social interaction ties as the first order variable (reflective)	Y	<ul style="list-style-type: none"> <li>Structural capital was positively related to individual message contribution</li> <li>Relational capital and cognitive capital failed to predict the message contribution behavior (hypotheses were not supported)</li> </ul>
		Relational capital	Second order reflective construct with trust and reciprocity as first order variables (reflective)	N	
		Cognitive capital	Second order reflective construct with shared vision and shared language as first order variables (reflective)	N	

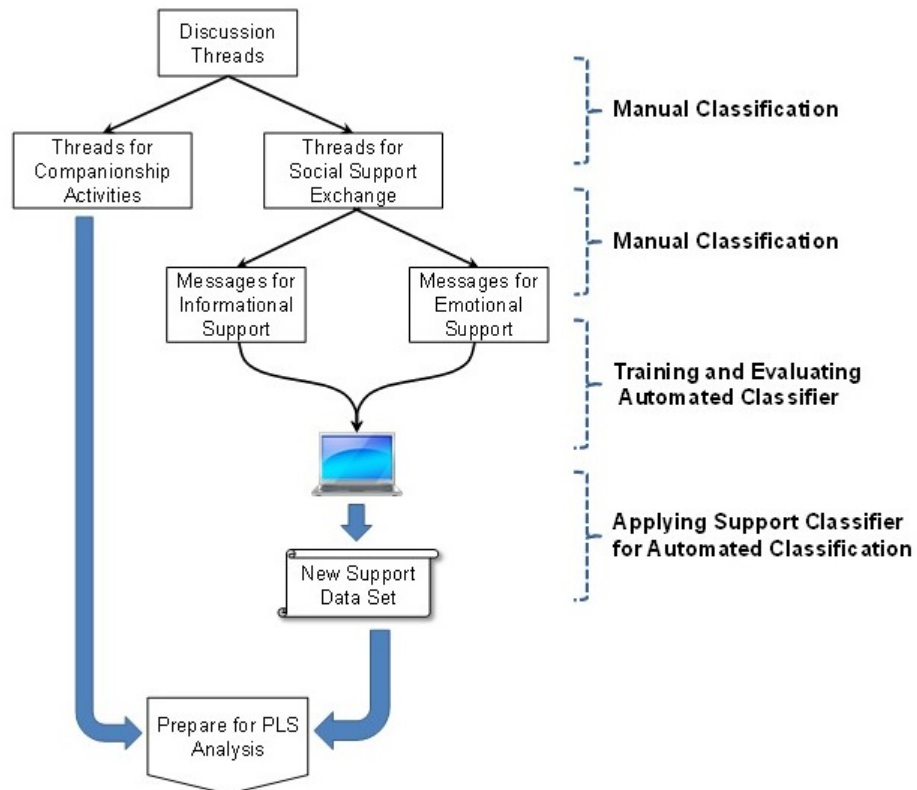
Author	Type of helping behavior (social support)	Manifested constructs	Operationalization (when measuring social capital dimensions directly)	Positively predict the provision of social support?	Major findings
Robert et al. 2008	Knowledge and information	Structural capital	Interaction intensity and degree centrality (aggregated as a single item)	N	<ul style="list-style-type: none"><li>Relational capital and cognitive capital both had positive impacts on knowledge integration and sharing</li><li>Structural capital failed to predict knowledge integration behavior (hypothesis was not supported)</li><li>When communicated through lean digital networks, structural and cognitive capital had stronger impacts on team members' knowledge integration and contribution</li></ul>
		Relational capital	Norms, social identity, trust, and obligation (reflectively)	Y	
		Cognitive capital	shared mental model	Y	
Components of Social Capital Dimensions as Predictors					
Chang and Chuang 2011	Knowledge and information	Social interaction ties (as a component of structural capital)		N	<ul style="list-style-type: none"><li>Individual online contribution behavior was determined by social identity, norm of reciprocity, shared language, and individual altruism</li><li>Social interaction ties, trust, and perceived reputation enhancement failed to predict online contribution behavior (hypotheses were not supported)</li><li>Altruism has a stronger effect on online contribution when members have higher levels of online participation involvement</li></ul>
		Trust (as a component of relational capital)		N	
		Social identity (as a component of relational capital)		Y	
		Reciprocity (as a component of relational capital)		Y	
		Shared language (as a component of cognitive capital)		Y	
Chiu et al. 2006	Knowledge and information	Social interaction ties (as a component of structural capital)		Y	<ul style="list-style-type: none"><li>Knowledge contribution behavior was predicted by social interaction ties, norm of reciprocity, social identity, shared vision (negative relationship, hypothesis was not supported), and community-related outcome expectations (e.g., help sustain the community, help enrich knowledge in the community)</li><li>Trust, shared language, and personal outcome expectations (e.g., enjoyment, reputation, making friends) failed to predict individual knowledge contribution (hypotheses were not supported)</li></ul>
		Trust (as a component of relational capital)		N	
		Reciprocity (as a component of relational capital)		Y	
		Social identity (as a component of relational capital)		Y	
		Shared language (as a component of cognitive capital)		N	
		Shared vision (as a component of cognitive capital)		N	



Author	Type of helping behavior (social support)	Manifested constructs	Operationalization (when measuring social capital dimensions directly)	Positively predict the provision of social support?	Major findings
He et al. 2009	Knowledge and information	Social interaction ties (as a component of structural capital)		Y	<ul style="list-style-type: none"> <li>Online knowledge contribution intention was affected by individual knowledge contribution belief (which is formed by online social relationship, enjoyment of helping, management influence, and effort required for contribution (-)) and individual knowledge contribution attitude</li> </ul>
		Trust (as a component of relational capital)		Y	
		Shared norms (as a component of cognitive capital)		Y	
Sarker et al. 2011	Knowledge and information	Communication centrality (as a component of structural capital)		Y	<ul style="list-style-type: none"> <li>Individual knowledge sharing behavior was predicted by his/her trust centrality and interaction centrality</li> <li>The level of knowledge possessed by an individual failed to predict his/her knowledge sharing activities (hypothesis was not supported)</li> </ul>
		Trust centrality (as a component of relational capital)		Y	
Wasko and Faraj 2005	Knowledge and information	Communication centrality (as a component of structural capital)		Y	<ul style="list-style-type: none"> <li>Community members helped others due to tangible returns (e.g., access to useful knowledge), intangible returns (e.g., personal enjoyment), and community interests (e.g., norm of reciprocity)</li> </ul>
		Reciprocity (as a component of relational capital)		N	
		Commitment (as a component of relational capital)		N	
		Tenure (as a component of cognitive capital)		Y	
		Expertise (as a component of cognitive capital)		N	
Wiertz and de Ruyter 2007	Knowledge and information	Reciprocity (as a component of relational capital)		N	<ul style="list-style-type: none"> <li>Online knowledge sharing behavior was predicted by individual online interaction propensity (which can be strengthened when norm of reciprocity increases) and individual commitment to the firm-hosted virtual community (the effect can be strengthened when one's online interaction propensity increases)</li> <li>Norm of reciprocity and individual commitment to the host firm failed to predict online knowledge sharing behavior (hypotheses were not supported)</li> </ul>
		Commitment to the community (as a component of relational capital)		Y	
		Commitment to the host firm (as a component of relational capital)		N	
Zhao et al. 2013	Knowledge and information	Trust (as a component of relational capital)		Y	<ul style="list-style-type: none"> <li>Knowledge contribution was predicted by social identity and empathy, which was determined by social identity and trust</li> </ul>
		Social identity (as a component of relational capital)		Y	

## Appendix B

### Automated Support Classification Tasks



# Appendix C

## Variables Used in this Study

Independent Variables	
Second-level construct	Structural Capital
First-level construct	Frequency of Interaction
Indicator	Frequency of Interaction (FI) (Adler and Kwon 2002)
<p>Description:</p> <p>Frequency of interaction is calculated as the average number of different threads in which one posted messages during the days one was present in the discussion board and posted messages (i.e., during the days one was active). This indicator represents the diversity of information received as well as the degree to which one has access to different members. Specifically, this indicator was calculated as</p> $\frac{\text{Sum of the number of the target member's thread participation for each of his / her active day}}{\text{number of days of the target member's community participation (i.e., active days)}}$ <p>We chose this conceptualization of structural capital over the often-used approach that relies on the degree of centrality measure as compared with pure quantitative measures, our conceptualization complements and promises a better understanding of the concept of structural capital and its manifestation in social relationships (Adler and Kwon 2002).</p>	
Second-level construct	Structural Capital
First-level construct	Intensity of Interaction
Indicator	Intensity of Interaction (II) (Adler and Kwon 2002)
<p>Description:</p> <p>Intensity of interaction was calculated as, of the threads one participated in on a day when s/he is present in the community, the average number of messages s/he posted in each thread. In other words, it represents the intensity of one's thread participation during the days one was present in the discussion board. The higher the value, the greater the depth of information exchanged (Yli-Renko et al. 2001). Specifically, this indicator was calculated as</p> $\frac{\text{Total number of messages posted by the target member during the collection period}}{\text{Sum of the number of thread participation for each of his / her active day}}$	
Second-level construct	Structural Capital
First-level construct	Multiplexity of Interaction
Indicator	Multiplexity of Interaction (MI) (Adler and Kwon 2002)
<p>Description:</p> <p>Multiplexity of interaction was measured as the degree to which one interacts with others on multiplex occasions (i.e., both for support and for companionship purposes) in the discussion board. It measures the degree to which the purpose of a community member's interactions has shifted from social support exchange to engagement in companionship activities. The higher the value, the higher the degree to which the member interacts with others not just for support purposes but also to fulfill intrinsic needs of social integration and enjoyment (Rook 1987, 1995). This highlights the diverse interactions between community members in HVSCs, representing additional channels for information exchange. Specifically, this indicator was calculated as</p> $\frac{\text{Number of members with whom one participated in companionship threads together}}{\text{Number of members with whom one participated in social support threads together}}$	

Second-level construct	Relational Capital
First-level construct	Social Norm (reflective construct)
Indicator 1	Norm of being Supportive to New Members (NM1) (Maloney-Krichmar and Preece 2002; Wellman et al. 1996)
<p>Description:</p> <p>Norm of being supportive to new members measures the degree to which one participated in discussion threads initiated by new community members—those who registered between June and August 2012 (i.e., the second dataset)<sup>1</sup>—when one participated in the community (i.e., during the days when one is active in the community). That is, on average, of the number of new-user-initiated threads one is exposed to on a day when s/he is present in the community, the actual number of these threads to which one posted messages.<sup>2</sup> Specifically, this indicator was calculated as</p> $\frac{\text{Number of the target member's message postings in threads initiated by new members}}{\text{Sum of the number of threads initiated by new members that have message - posting activities on the days when the target member is active in the community (number of thread participation opportunities to help newcomers)}}$	
Indicator 2	Norm of being Supportive to Community Members (NM2) (Maloney-Krichmar and Preece 2002; Wellman et al. 1996)
<p>Description:</p> <p>The norm of being supportive to other members is also measured as the degree to which one participated in discussion threads to support others (Wellman et al. 1996), either friends or new members. This indicator measures, on average, of the different members one has the opportunity to help (i.e., those members' threads had message-posting activities) during the days when s/he is present in the community, the actual number of their threads in which s/he posted messages. Specifically, this indicator was calculated as</p> $\frac{\text{Number of different members whose threads were joined by the target member during his / her active days}}{\text{Sum of the number of different community members the target member had the opportunity to help during his / her active days}}$	
Second-level construct	Relational Capital
First-level construct	Trust (reflective construct)
Indicator 1	Self-Disclosure in Emotional Support Messages (TR1) (Callaghan et al. 2013; Houghton and Joinson 2012)
<p>Description:</p> <p>Self-disclosure represents one's willingness to trust and take risks in disclosing personal and sensitive information (Grabner-Kräuter 2009). It also signals that the discloser trusts and values the receiver's opinion (Jiang et al. 2011). Self-disclosure in this study was objectively measured by applying the Linguistic Inquiry and Word Count (LIWC) software package (Pennebaker et al. 2007) to analyze online message content. LIWC is a research tool used to search text documents and count the frequencies of the occurrence of words belonging to each of the 68 pre-defined word categories. Following previous studies using LIWC to assess the degree of self-disclosure (e.g., Callaghan et al. 2013; Houghton and Joinson 2012), LIWC categories including first-person singular pronoun (e.g., I, my), first-person plural pronoun (e.g., we, our), family (e.g., husband, mom), friend (e.g., neighbor, roommate), positive emotion (e.g., love, happy), and negative emotion (e.g., hurt, insult), were used to identify self-disclosure words in online messages. Two reflective indicators were generated for measuring trust based on these LIWC categories. The first indicator is the ratio of self-disclosure words in emotional support messages posted by an individual, to the total number of words in these messages. Specifically, this indicator was calculated as</p> $\frac{\text{Total number of self disclosure words (identified via LIWC) in emotional support messages posted by the target member}}{\text{Length of all the emotional support messages (as number of words) posted by the member}}$	

<sup>1</sup>While we took into account the threads posted by members registered during the second dataset period in calculating and generating this variable, these new members, as indicated above, were not considered as the sample of this study.

<sup>2</sup>In the target discussion boards, discussion threads are listed in a reverse chronological order based on the date and time they were last responded. In this study we used the number of threads that had message-posting activities during the day the target member also posted messages as a proxy of the number of threads s/he was exposed to on that day.

Indicator 2	Self-Disclosure in Informational Support Messages (TR2) (Callaghan et al. 2013; Houghton and Joinson 2012)
<p>Description:</p> <p>The second indicator of the Trust construct is the ratio of self-disclosure words in informational support messages posted by an individual, to the total number of words in these messages. Specifically, this indicator was calculated as</p> $\frac{\text{Total number of self disclosure words (identified via LIWC) in informational support messages posted by the target member}}{\text{Length of all the informational support messages (as number of words) posted by the member}}$	
Second-level construct	Relational Capital
First-level construct	Social Identity (formative construct)
Indicator 1	In-Group Liking (SI1)
<p>Description:</p> <p>In-group liking results from one's identification of group members in terms of their embodiment of the group prototype (Bergami and Bagozzi 2000; Hogg and Terry 2000). Hogg and Terry (2000) called it "social attraction," by which one intends to friend others due to shared group membership (Bergami and Bagozzi 2000). According to the SIDE model (Postmes et al. 2005; Spears and Lea 1994), such a group-based liking tends to take place in virtual settings. Recognizing that in the target HVSC, members can set each other as friends, we measured in-group liking as the number of friend assignments made by community members.<sup>3</sup> As a measurement capturing the degree to which a community member feels a sense of liking for, and an interest in socializing with, other members, this indicator represents the degree to which one (affectively) identifies with the community. Specifically, this indicator was calculated as</p> $\text{Total number of community-friends the target member has in the target discussion board}$	
Indicator 2	Favorable In-Group Evaluation (SI2) (Cassell and Tversky 2006)
<p>Description:</p> <p>Favorable in-group evaluation represents the "evaluative" component of social identity, concerning a positive value connotation of being a group member (Bergami and Bagozzi 2000; Ellemers et al. 1999). Motivated by an intrinsic need for self-esteem, this aspect of social identity reflects one's selective evaluation in favor of the group one identifies with when comparing in-group and out-group memberships (Hogg and Adams 1988). According to Brewer and Gardner (1996), and Perdue et al. (1990), such an evaluative bias toward the group is evoked automatically as group members use words referring to in-group categorization (e.g., we, our). As suggested by previous research (e.g., Cassell and Tversky 2006), we used the ratios between individuals' uses of pronouns in messages that connote in-group favoritism, that is, <i>we-words</i> (e.g., we, our) and their uses of <i>I-words</i> (e.g., I, me) in social support messages to measure one's positive evaluation toward the HVSC. LIWC was applied to identify we-words and I-words in messages. Specifically, this indicator was calculated as</p> $\frac{\text{Number of "We" words used in the member's social support messages}}{\text{Number of "We" words + "I" words used in the member's social support messages}}$	

<sup>3</sup>Similar to the feature of social networking communities, in the target HVSCs a member can friend other community members (either the member accepted friend assignments from others or got accepted as a friend by others). The list of community "friends" a member has is open to all registered members.

Second-level construct	Cognitive Capital
First-level construct	Shared Language (reflective construct)
Indicator 1	Prototypical Language Similarity (SL1) (Baeza-Yates 1999)
<p>Description:</p> <p>This indicator was generated by applying an approach commonly used in the Information retrieval and natural language processing disciplines to analyze online messages. Specifically, we applied the vector-space model (VSM) and the term-frequency-inverse-document-frequency (<i>tf-idf</i>) weighting approach (Baeza-Yates 1999) to generate a prototypical message that represents the common language shared by community members. The basic idea of a prototypical message is that the words that appear frequently in messages of one community but not other communities should represent the shared language used by members of that community.<sup>4</sup> Based on the prototypical message, we compared the similarities (based on cosine similarity) between it and each community member's messages. The closer a member's messages to the prototypical message, the more the member used community-specific language in his/her messages. Specifically, this indicator was calculated as</p> <p>Cosine similarity between the messages posted by the target member (represented as a vector of <i>tf-idf</i>-weighted terms) and the prototypical message of the target discussion board (the mean of all the message vectors of the discussion board)</p>	
Indicator 2	LDA Topic Diversity (SL2) (Wu 2013)
<p>Description:</p> <p>This indicator measures the extent to which a community member's word uses covered different discussion themes of the community, which was calculated as a two-stage process. At the first stage, we applied Latent Dirichlet Allocation (LDA), the most commonly used approach for topic modeling—machine learning techniques applied to infer the themes or patterns of word-use that characterize the observed collection of documents (Blei 2012)—to analyze the collected messages. LDA inferred a set of topics (e.g., treatment, medication, healthcare provider) statistically from the words used in discussion messages of the cancer discussion boards (messages from the three discussion boards were analyzed separately). These topics, represented in a vector space, can be regarded as the content areas of the respective boards. Following a similar approach to measure information diversity using LDA in the IS literature (Wu 2013), community members' levels of using community-specific language were then calculated at the second stage. At this stage, each member's words collection in his/her messages were converted into the topic vector space using LDA, and its vector similarity against the content vector of the whole discussion board was measured. The higher the similarity value, the more the community topics one's word uses span. Similar to the first indicator, this indicator captured the degree to which one's word uses in one's messages resembled the (topic) vector representing a given discussion board. Specifically, this indicator was calculated as</p> <p>Cosine similarity between the topic vector derived via LDA based on message discussions in the target discussion board and the topic vector derived via LDA that capture the target member's message postings.</p>	

<sup>4</sup>Through the VSM approach, each message posting  $j$  was converted into a vector of weighted index terms  $(w_{1j}, w_{2j}, \dots, w_{tj})$ , in which index terms 1 through  $t$  are words occurring in the message collection and the weight of each index term with regard to a given message represents the importance of the index term for describing that message. In the *tf-idf* approach, the *term frequency* of each index term  $i$  with regard to a given message  $j$ ,  $f_{ij}$ , is calculated as  $f_{ij} = \text{freq}_{ij} / \text{max freq}_j$ , where  $\text{freq}_{ij}$  is the number of times the term  $i$  occurs in the message and  $\text{max freq}_j$  is the maximum frequency occurrence across all the terms appearing in message  $j$ . If an index term does not appear in the message,  $f_{ij} = 0$ . The *inverse document frequency* for an index term  $i$  across the message collection is calculated as  $\text{idf}_i = \log(N/n_i)$ , where  $N$  is the total number of messages in the collection, and  $n_i$  is the number of messages in which the index term  $i$  appears. The weight of an index term  $i$  with regard to a given message  $j$ ,  $w_{ij}$ , therefore is calculated as  $w_{ij} = f_{ij} \times \text{idf}_i$ . In this study the conversion of each message into its vector representation is based on all the messages of colorectal cancer, prostate cancer, brain cancer, ovarian cancer, and lymphoma discussion boards. In the generation of the prototypical messages for the three target discussion boards of this study, we calculated the means of all the message vectors of the corresponding message boards.

Second-level construct	Cognitive Capital
First-level construct	Healthcare-Related Expertise
Indicator	UMLS concept count (HRE)
<p>Description:</p> <p>The level of healthcare-related expertise was measured by calculating community members' uses of Unified Medical Language System (UMLS) in their messages. UMLS (Bodenreider 2004) is an online meta-thesaurus of controlled vocabularies of biomedical terminologies developed by the U.S. National Library of Medicine (NLM). Each term in the UMLS belongs to one or more of the total of 135 semantic types such as "Disease or Syndrome" (e.g., infection, lymphedema), or "Therapeutic or Preventive Procedure" (e.g., chemo, reconstruction).<sup>5</sup> To generate the desired variable, we measured the total number of different UMLS semantic types identified in one's informational and emotional support messages. This indicator captures the degree to which a community member expresses his/her healthcare-related knowledge when interacting with other members. Specifically, this indicator was calculated as</p> <p style="text-align: center;">Number of distinct UMLS semantic types identified in the target member's social support messages</p>	
<b>Dependent Variables</b>	
Construct	Informational Support (reflective construct)
Indicator 1	Informational Support Count
<p>Description:</p> <p>This indicator measures the number of informational support messages one posted in the discussion board. Specifically, this indicator was calculated as</p> <p style="text-align: center;">Number of informational support messages posted by a member</p>	
Indicator 2	Informational Support Length
<p>Description:</p> <p>This indicator measures the amount of support one provides in one's informational support messages. Specifically, this indicator was calculated as</p> <p style="text-align: center;">Word count in all the informational support messages posted by the target member</p>	
Construct	Emotional Support (reflective construct)
Indicator 1	Emotional Support Count
<p>Description:</p> <p>This indicator measures the number of emotional support messages one posted in the discussion board. Specifically, this indicator was calculated as</p> <p style="text-align: center;">Number of emotional support messages posted by a member</p>	
Indicator 2	Emotional Support Length
<p>Description:</p> <p>This indicator measures the amount of support one provides in one's emotional support messages. Specifically, this indicator was calculated as</p> <p style="text-align: center;">Word count in all the emotional support messages posted by the target member</p>	

<sup>5</sup> MetaMap, a software tool that applies the UMLS for identifying biomedical concepts in texts, was used to analyze collected messages and map word occurrences to UMLS semantic types (Aronson 2001).

Construct	Companionship Activities (reflective construct)
Indicator 1	Companionship Activities Count
Description: This indicator measures the number of messages one posted to companionship activity threads in the discussion board. Specifically, this indicator was calculated as  Number of messages posted by a member to the companionship activity threads	
Indicator 2	Companionship Activities Length
Description: This indicator measures the amount of companionship activities one participated in in the discussion board. Specifically, this indicator was calculated as  Word count in all the companionship activity messages posted by the target member	

## Appendix D

### Results of Mediation Analysis

The associations among the social capital dimensions in our proposed model called for a test of mediation effects. We applied a bootstrapping approach to estimate standard errors and to test the significance of the mediating effects (Henseler et al. 2009). Bootstrapping is a preferred approach for testing mediation effects over the widely used Sobel test (Sobel 1982), as it does not impose strict sample size and distribution requirements (Hayes 2009; Preacher and Hayes 2008). The results indicate that cognitive capital significantly mediated the effects of structural capital on emotional support ( $\beta = 0.20$ ,  $P < 0.01$ ) and informational support ( $\beta = 0.51$ ,  $P < 0.01$ ). Additionally, while relational capital did not mediate structural capital's impacts on the provision of informational support, it significantly mediated the impact of structural capital on emotional support provision ( $\beta = 0.12$ ,  $P < 0.01$ ). Furthermore, relational capital significantly mediated the effects of structural capital on companionship activities ( $\beta = 0.12$ ,  $P < 0.05$ ).

We also applied Baron and Kenny's (1986) method to compare mediated and unmediated models linking structural capital to social support provision. By changing from a model without cognitive capital and its components to a full mediation model (our research model), the direct effect of structural capital on informational support changed from significant to nonsignificant ( $\beta = 0.37$ ,  $P < 0.01 \rightarrow \beta = -0.08$ ,  $P > 0.05$ ), and its direct effect on emotional support also substantially decreased ( $\beta = 0.48$ ,  $P < 0.01 \rightarrow \beta = 0.27$ ,  $P < 0.01$ ). This confirms that cognitive capital fully mediated the impact of structural capital on informational support, and a partially mediated structural capital's effect on emotional support. The same procedure was applied to examine the mediation effect of relational capital, and the result shows that relational capital partially mediated the effects of structural capital on emotional support ( $\beta = 0.38$ ,  $P < 0.01 \rightarrow \beta = 0.27$ ,  $P < 0.01$ ) and companionship activities ( $\beta = 0.61$ ,  $P < 0.01 \rightarrow \beta = 0.49$ ,  $P < 0.01$ ).

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